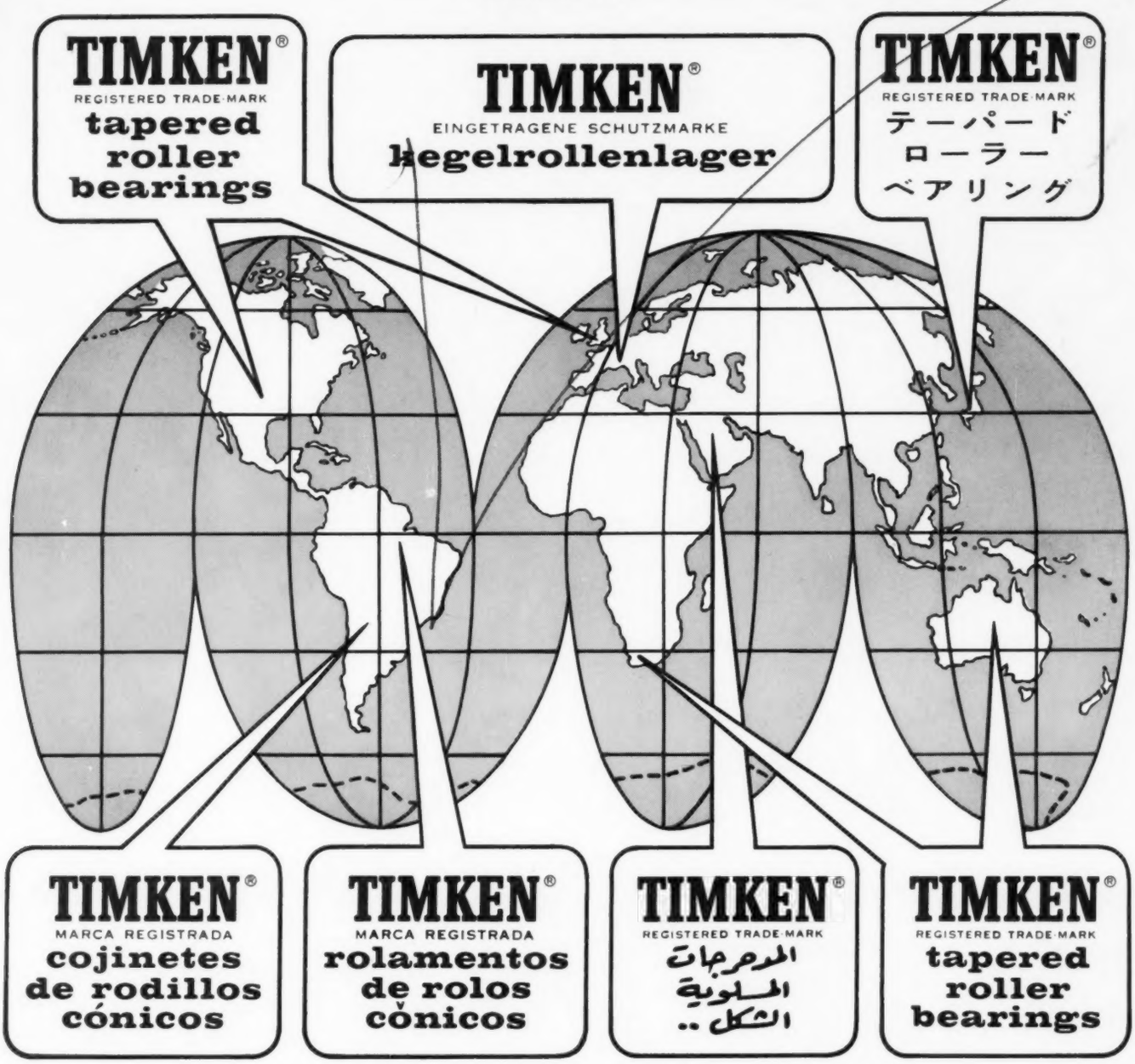
Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

NOVEMBER 1961



NO MATTER WHAT THE LANGUAGE, you're protected when the trade-mark "Timken" is on the bearings that support the loads in your machines. You're protected because Timken tapered roller bearings give long, trouble-free life in automobiles, machine tools, trains, farm equipment — wherever wheels and shafts turn.

And when you buy Timken bearings, you're assured of the engineering service of the world's most experienced and largest manufacturer of tapered roller bearings. The name "Timken" is a trade-mark identifying the bearings, steel and rock bits made by The Timken Roller Bearing Company and its subsidiaries and divisions the world over. The Timken Roller Bearing Company, Canton 6, Ohio, U.S.A. Cable address: "TIMROSCO". Timken bearings manufactured in U.S.A., Australia, Brazil, Canada, England and France.

Painting by Jack Kraft

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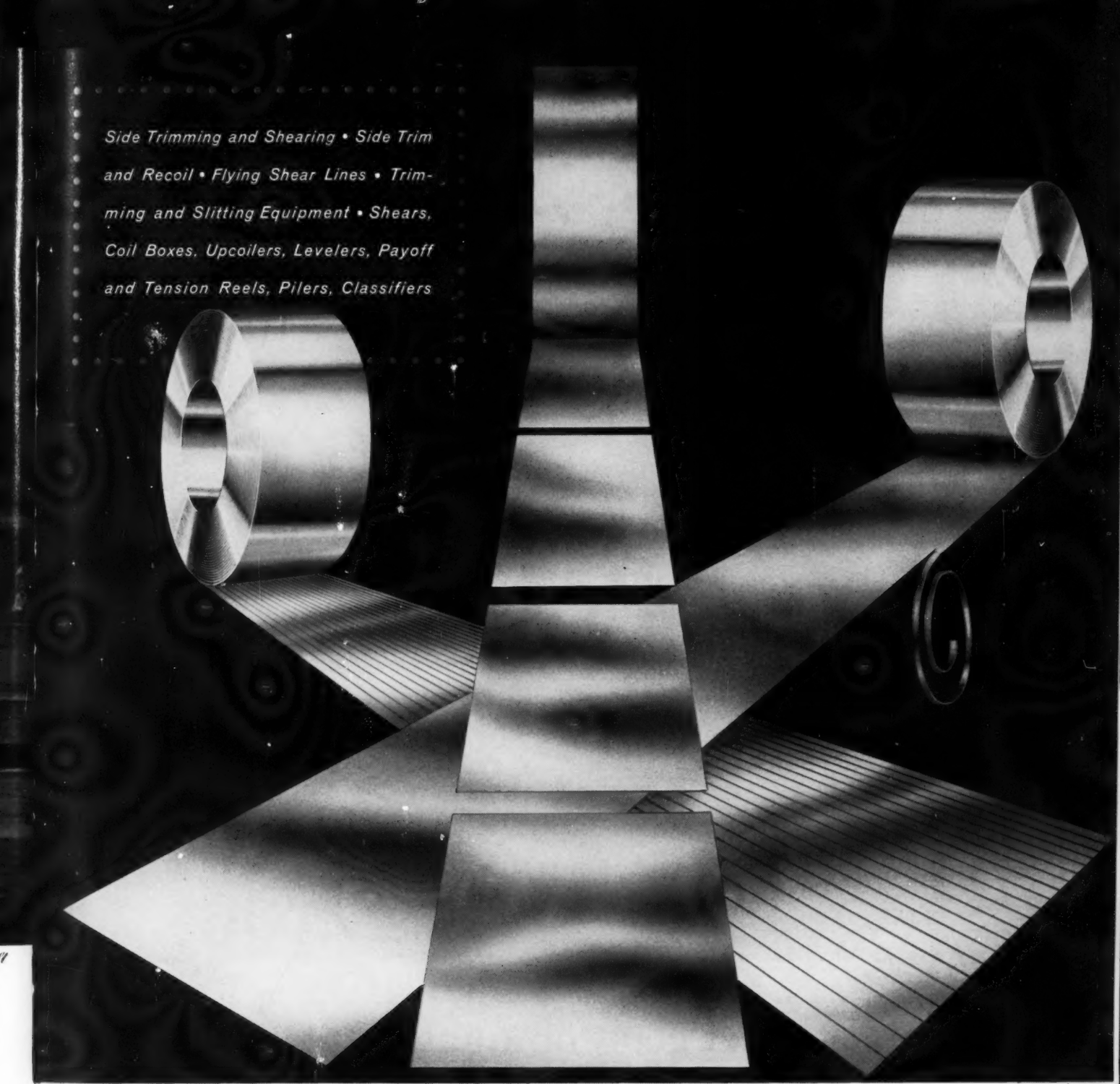
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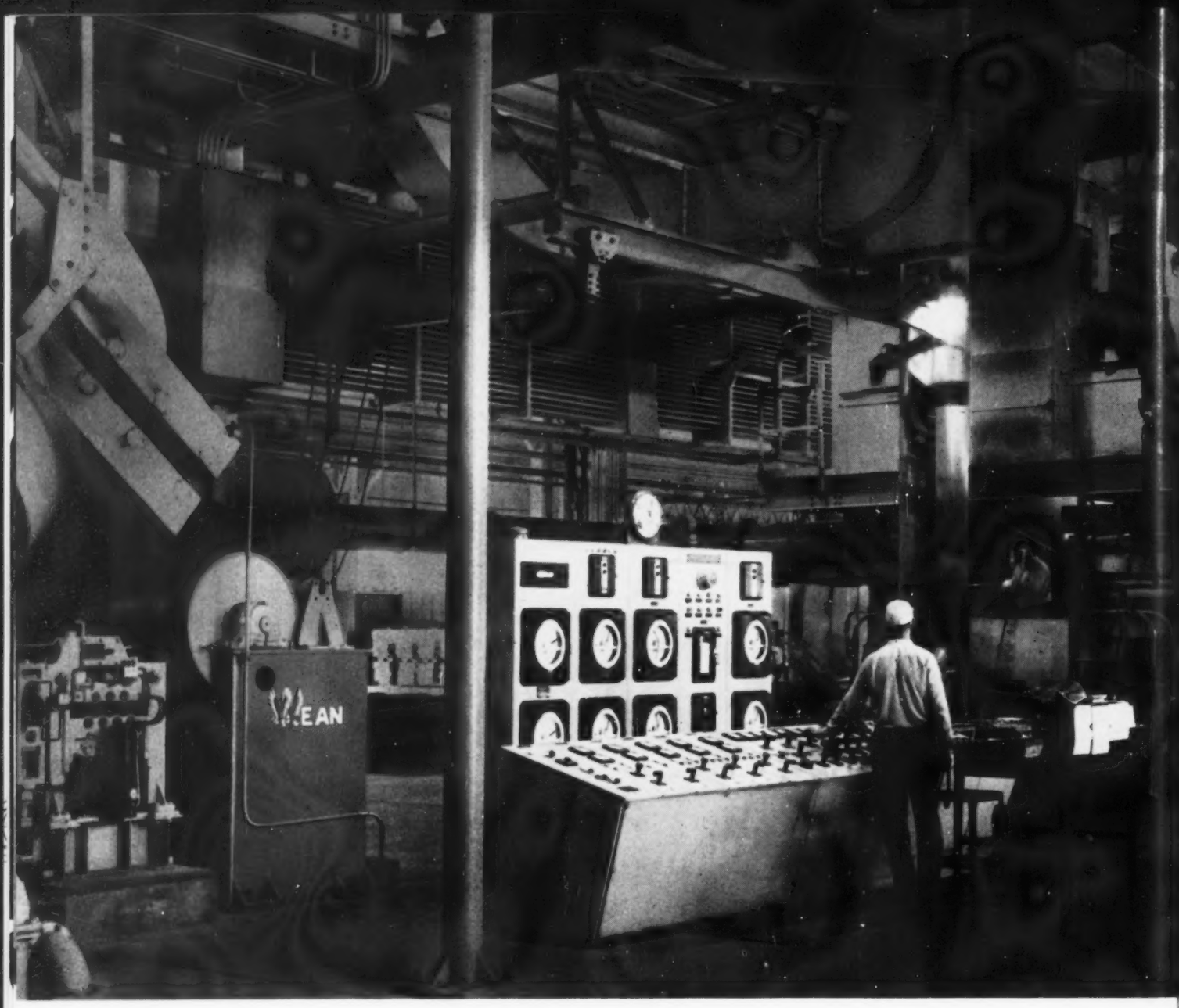

Reeves Steel gets top quality product, record output from Wean Galvanizing Line

The quality reputation of Reeves TiteKote® galvanized steel—and Reeves finished galvanized products—is well established. Produced by the Reeves Steel and Manufacturing Division of Empire-Reeves Steel Corporation on a 36″ Wean line, TiteKote's excellent quality derives from both the outstanding operating practices of Reeves personnel and dependability of the equipment.

Installed at the Reeves Mill in Dover, Ohio in 1955, the Wean line has given trouble-free service since start-up. The Wheeling-type line handles gauges from 16 to 30, top speed on the lighter materials being 310 fpm. Strip from 18″ to 36″ wide in coils up to 26,000 lbs. is fed to the line after annealing and a temper pass on a two-high mill.

Wean's experience in continuous processing line design and construction has been built over 31 years service to the steel industry. Wean's "creative engineering" can make a major contribution to expansion or modernization of your finishing facilities.

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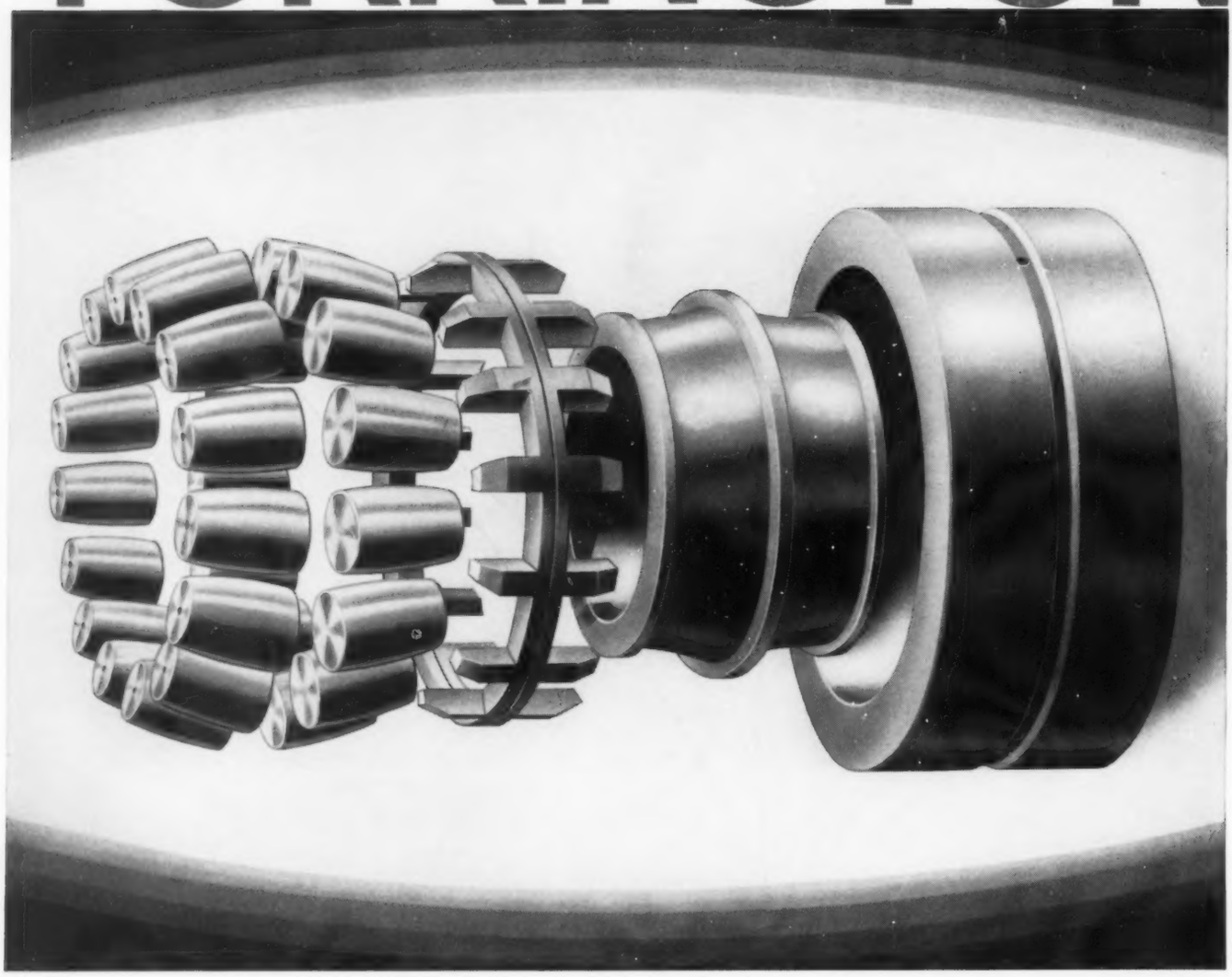
TORRINGTON



FOR THE INSIDE STORY...

...ON TORRINGTON SPHERICAL ROLLER BEARINGS, one word: *precision*. Each individual part is precision-engineered to the highest standards in the industry... functions precisely and efficiently with all other parts.

Every roller is matched electronically within .0001" for even-load distribution and maximum capacity.

Each independent land-riding cage spaces rollers precisely... prevents roller drag even under the heaviest loads and possible misalignment.

The integral guide flange is ground to a common spherical radius with the roller ends for positive roller guidance, greater stability.

For minimum friction and wear, both inner and outer races are precision ground to conform exactly to roller contours.

Put together... a Torrington Spherical Roller Bearing for superior performance, reliability and long service life. Buy the best...specify Torrington.

SUPERIOR PERFORMANCE FEATURES OF TORRINGTON SPHERICAL ROLLER BEARINGS

- ☐ inherent self-alignment
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- ☐ integral center guide flange for stability
- ☐ positive roller guidance
- ☐ land-riding bronze cages
- ☐ maximum radial and thrust capacity
- ☐ controlled internal clearance
- ☐ electronically selected rollers
- ☐ even load distribution
- ☐ long, dependable service life

progress through precision

THE TORRINGTON COMPANY

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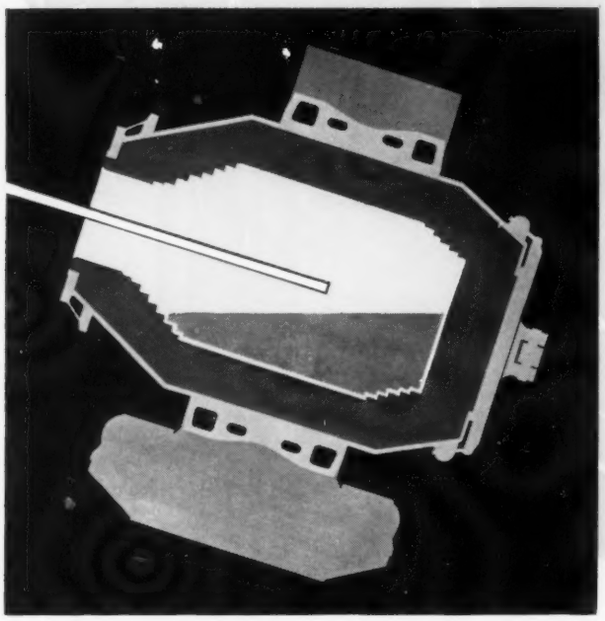
KALDO



Davy-United are equipped to give a complete service covering the design, engineering, supply, erection and commissioning of Kaldo furnaces from individual converters to complete Kaldo steel melting shops.

Davy-United experience in Kaldo furnace design includes the overall engineering layout of the first complete Kaldo steel melting shop in the United Kingdom. This plant is designed for continuous production and incorporates two 55 ton Kaldo furnaces.

Steel Processes Division

DAVY-UNITED | **DAVY-ASHMORE GROUP**

DAVY AND UNITED ENGINEERING COMPANY LIMITED . SHEFFIELD . ENGLAND

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561

DE LAVAL

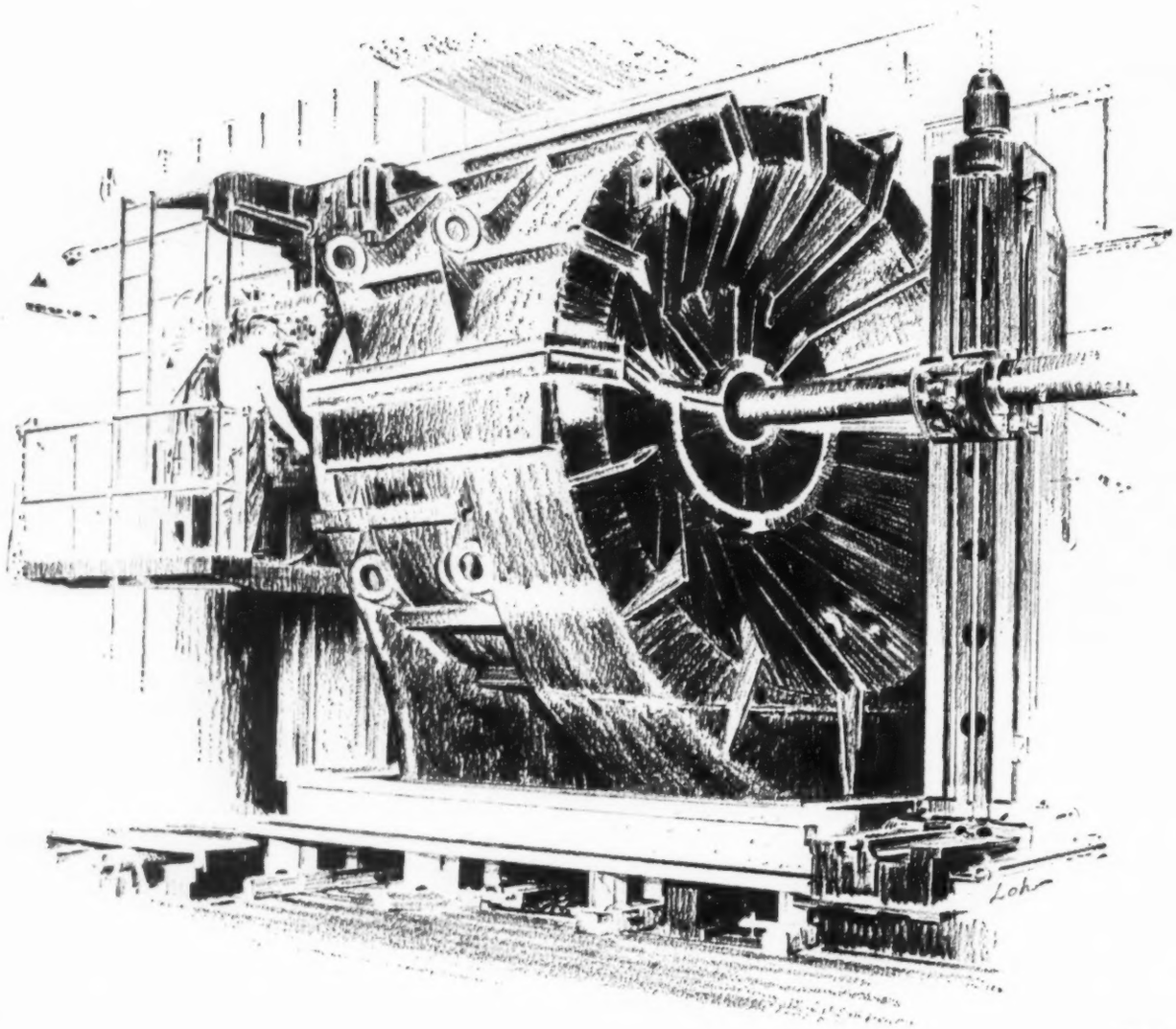
creative engineering helps boost steel output

Bigger blast furnaces offer economy to the steel industry . . . and a challenge as well. Could engineers boost the size, pressure, and efficiency of the blowers which supply combustion air and still maintain the desirable operating characteristics and rugged construction of centrifugal blower design?

The De Laval answer is this new, high-efficiency centrifugal blower for capacities up to 175,000 cubic feet of air per minute . . . an increase of 40% over previous industry standards. The all-steel casing permits an increase in discharge pressure to 50 psig.

Whether you are building bigger blast furnaces or have other problems involving rotating machinery, De Laval creative engineering can help.

De Laval Steam Turbine Company, Trenton 2, N. J.



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DE LAVAL · 60 YEARS OF CREATIVITY AND QUALITY

CENTRIFUGAL PUMPS AND COMPRESSORS • TURBINES • IMO® ROTARY PUMPS AND HYDRAULIC MOTORS
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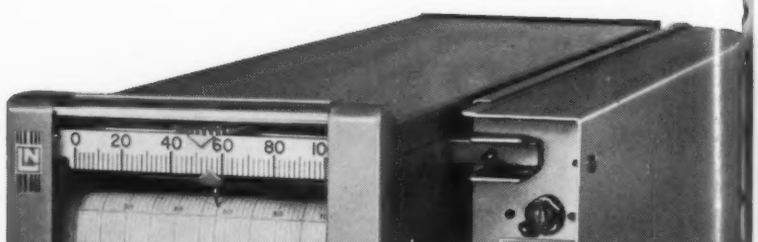
OPEN UP: for better drawing quality steel

The uniformity of anneal possible only through the Open Coil Process means a more uniform Rockwell with more uniform drawing quality throughout the entire coil. This enables a steel producer to duplicate orders, providing the same steel time after time, so that one stamping plant will be using precisely the same steel as another — an important consideration for decentralized manufacturing. "Stickers" are eliminated, and it is now possible to roll smoother deep-draw steels with better surface qualities for improved end products. For further information write the *Lee Wilson Engineering Co., Inc., 20005 Lake Road, Cleveland 16, Ohio.*

Lee Wilson

Originators and Leading Producers of Open Coil and Single Stack Furnaces

PRESENTING M LINE



***M-LINE CONTROLLER** . . . heart of the M-Line Control system*

Not "just another" electronic miniature line . . . but the most advanced design for process control

Evaluate it yourself, against *your* control requirements. You'll quickly find that M-Line is the one miniature electronic control that's significantly different.

Based not only on L&N's direct experience in designing and building more than 70,000 electronic controllers, but incorporating as well many of the ideas suggested by instrument specialists in the process industries, this advanced instrumentation offers you a unique combination of advantages:

WIDEST SCOPE OF COMPATIBILITY IN OPERATION Can be used with virtually any commercially available primary element transmitter which produces a d-c current or voltage signal; can be integrated with data-handling or computing equipment;

SIMPLEST FUNCTIONAL DESIGN . . . Operation is uncomplicated, quickly understood by operators;

UNMATCHED INTERCHANGEABILITY OF COMPONENTS M-Line display and/or control units of varying sophistication can be readily substituted (simply plugged into the basic stations) even after installation and start-up;

OUTSTANDING FLEXIBILITY IN OPERATION AND IN APPLICATION. . . By-pass of signal to "end-operator" permits process operation even when various control system components are removed. Additionally, standard M-Line components form building-blocks for control systems of varying complexity.

Check the features listed . . . just a few of the engineering details that make M-Line an exceptionally sound and economical investment. Your local L&N representative has the full story . . . or for more detailed information write to Leeds & Northrup Co., 4942 Stenton Ave., Philadelphia 44.

LEEDS & NORTHRUP CO

M-LINE CONTROL STATION

Unitized construction—only 6″ x 6″ front-of-panel space required for complete one- or two-pen recorder and controller, including set-point unit, auto-manual unit, and control unit.

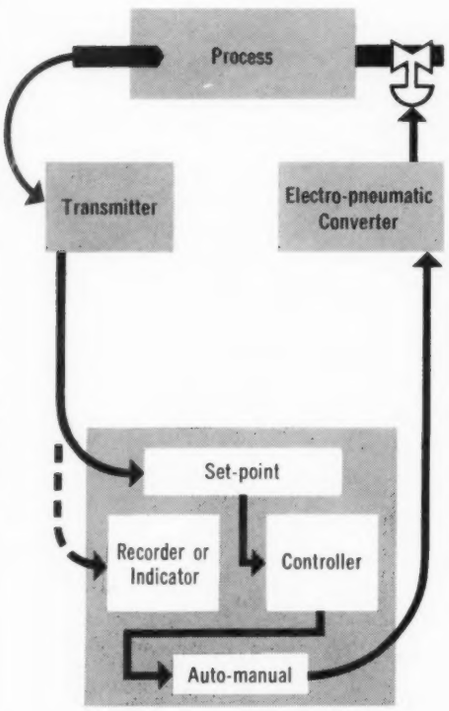
Simple auto-manual circuit design guarantees "bumpless" transfer from manual to auto, whether "on" or "off" control point—no balancing required. Easy to read—set-point index and measuring index use same calibrated scale.

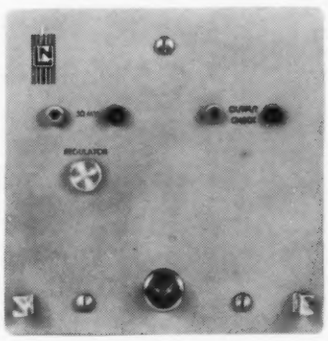
Controller transistorized, with high-impedance Nuvistor input stage—circuitry proved by years of industrial experience. Deviation from set-point will produce rate action, but due to circuit design, no rate upset is introduced when changing the set-point itself.

Control function adjustments in rear, to prevent tampering by unauthorized personnel.

Forward- or reverse-acting control achieved by switches, protected by foolproof locking plates; auto-manual station operation always the same, regardless of direction of control.

Available with 2- or 3-mode controllers. Proportional Band: 0–300%, continuous. Reset: Adjustable from 0.2 to 1000 repeats per minute for 2-mode controllers, 18 well-spaced steps; 0–100 repeats per minute for 3-mode controllers, 18 well-spaced steps. Rate: 0–8 minutes, continuous.





M-LINE TC/EMF TRANSMITTER

Measures any 0–5 to 0–60 mv d-c signal span from −60 to +60 mv.

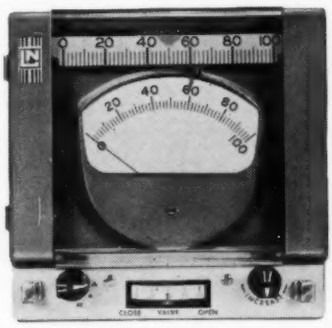
Transistorized circuits; Zener-diode reference.

All TC/EMF amplifiers interchangeable, regardless of application.

Range, reference junction compensation, and zero suppression resistors mounted on easily-changed card on terminal board.

Noise-free output signal with standard ranges of 1–5 ma or 0–4 ma into 500 to 2500-ohm load.

Input and output completely isolated—avoids grounding problems.



M-LINE INDICATORS

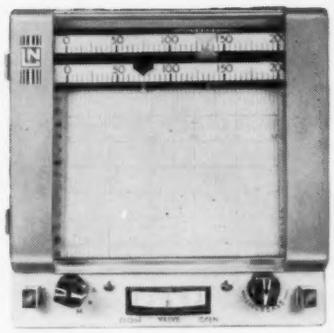
Available as one- or two-point indicators.

Clear, 3″ scale-length with continuous indication.

Easy to install and service; completely interchangeable with recorder—same case, same plug-in attachments.

LEEDS & NORTHRUP

Pioneers in Precision



SPEEDOMAX M RECORDERS

Available as one- or two-pen recorder with amplifiers completely encased.

4″ vertically-driven chart with continuous line record.

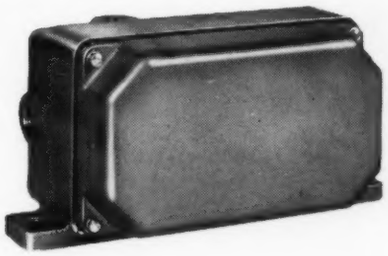
Potentiometric measurements of 4 v d-c (0–4 ma or 1–5 ma) using high-torque servo mechanism with optional retransmitting slidewires and high and low alarm contacts.

Recorder completely independent of the control circuit.

Recorder amplifier circuitry on printed cards for simplicity.

Sturdy 6″ x 6″ x 23″ case and rugged mounting—withstands rough handling and supports unusual loads.

Available with mercury-bottle disconnects for use in Class 1, Group D, Division 2, and many other safety features.



M-LINE ELECTRO-PNEUMATIC CONVERTER

Mounts in any position, in any location.

Resistant to vibration.

Weather-proof.

Maximum safety: uses minute energizing current, provides continuous air-purge of fumes.

Pressure output can be locked-up, in event of power failure.

Can be used with any controller having a 1 to 5 ma d-c current output.

Cleveland Cranes
FOR
STEEL MILL SERVICE
CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES
5031 E.289th ST.
WICKLIFFE,
OHIO

Crops *and* Shorts

△ American steel companies continue to look abroad. United States Steel Corp. is entering a joint project with Terni Societa per L'Industria e L'Elettricita to set up a new Italian company to make stainless steel. The rolling facilities should be in operation late in 1963.

Also, Jessop Steel Co. is planning a tentative program for a joint venture in India with Vummidiars Private Ltd. This project would include a $5,000,000 alloy steel plant for ingots, forgings, flats and bars.

△ The British publication, "Metal Bulletin," commenting on excess steelmaking capacity in many countries, says: "A leaner time seems inevitable. Experience has shown, of course, that the modern steelworks can work economically at a much lower capacity usage figure than at one time was thought possible. Government protection may save high-cost plants in some countries, but where economic forces are allowed to exert themselves without too much manipulation, the recession will bring a great winnowing out of old and uneconomic plants. This is already happening in the United Kingdom. Such sharp surgery, painful as it may be socially, is beneficial economically—it reduces surplus capacity and tones up the industry for the next boom."

△ After observation at several beaches during the past summer, we have come to agree that girls in bikinis are like amateur snapshots—underdeveloped or overexposed.

△ The first prediction of 1962 steel production comes from John F. Smith, Jr., president of Inland Steel Co., who looks for 110,000,000 to 115,000,000 net tons of ingots.

△ Arthur B. Homer, chairman of Bethlehem Steel Co., said that steel prices have brought expression of "a great deal of concern" recently. He said: "It would be encouraging to see evidence of equal concern for profits."

△ A correspondent defines economy as a way of spending money without getting any pleasure out of it.

△ Forrest H. Kirkpatrick of Wheeling Steel Corp. told a National Association of Manufacturers conference: "Because of persistent unemployment and the realization of some union leaders that wage boosts not warranted by an increase in productivity will merely accelerate the introduction of labor-saving devices, next year should be marked on the whole by general labor peace."

△ The recent conference in Vienna on oxygen steelmaking reports progress in making special alloy and stainless steels and in the use of more scrap in the process.

△ Russia is talking of 900-ton open hearths, 300-ton arc furnaces and oxygen converters of 250 tons or more.

△ The proposed expansion of the Japanese steel industry may be slowed by the Japanese government's efforts to stem a balance-of-payments deficit.

△ J. D. McCall, president of Columbia-Geneva Division of United States Steel Corp., told the California Industrial Development Conference that progress in industry, especially steel, is being "pinched" by a failure to recognize the value of engineering, research and production skills, which are being handicapped by heavy taxation, and a lack of recognition of sociological and technical changes brought about by present-day competitive conditions.

△ The Wall Street Journal observes that a holiday is a day off followed by an off day.

△ The consensus of 316 economists surveyed in the annual poll by F. W. Dodge Corp. is that all major indicators of the economy will advance in 1962, many of them setting new records. The majority think the recovery will continue to be centered in the manufacturing sector of the economy, particularly in durable goods manufacturing.

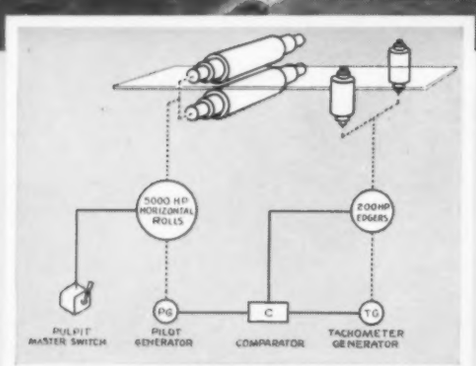
△ Arnold Hoffman, former president of Mesabi Mining Co., told the New York Society of Security Analysts that the United States steel industry will require 200,000,000 tons of iron ore a year by 1985.

△ The demand for coal in the United States should reach 670,000,000 tons a year by 1975, according to T. Reed Scollon of the U. S. Bureau of Mines. Most of the increase will result from projected expansion of electric power generation. Approximately 90,000,000 tons of coal will be needed for metallurgical coke in 1975, as against slightly more than 80,000,000 tons in 1960.

△ Our well-to-do friend agrees that a miser might be tough to live with but says he makes a nice ancestor.

△ Research spending in the United States will total almost $16,000,000,000 in 1962, according to George W. James, economist at Battelle Memorial Institute.

EC&M-controlled 130-inch helps produce world's



• The EC&M screwdown controller on this mill is operated directly by the roller, is adaptable for auto-positioning and automatic sequencing control in the future.

• EC&M has built and is building control systems for automatic operation of screwdowns and side guides through punched cards or slider-contact panels. Systems which tie in auxiliary and main drives under a single push button automated operation are also available.

SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

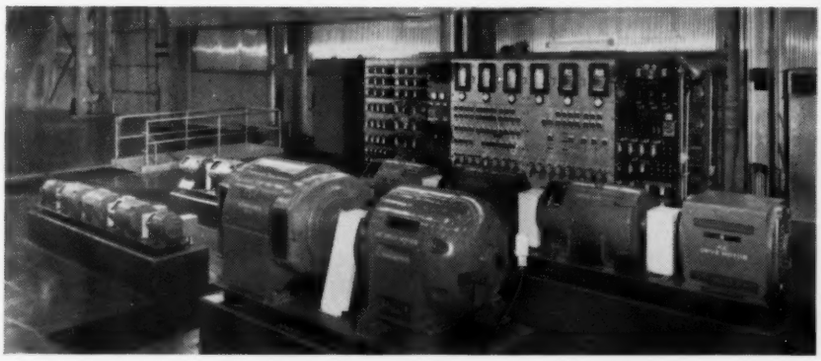
Reversing Rougher widest aluminum strip

THE WIDEST aluminum coiled sheet ever made—115 inches—is produced at Reynolds Metals Company's Alloy Plant in Sheffield, Alabama. Control for the 130-inch reversing hot mill was engineered and built by EC&M.

Operated by a single man in the pulpit, this new mill installation quickly attained full production. The EC&M control system provides the speed matching and draft compensating requirements of both the main and vertical roll drives. The use of existing rotating equipment resulted in extra economies, and drives were computer-analyzed to assure an accurately designed control which would require a minimum of tune-up time.

EC&M is prepared to build complete control systems for reversing and non-reversing mill drives, including the associated mill auxiliary drives. Let EC&M help solve your mill control problems.

All apparatus shown below, including M-G sets as well as screwdown and adjustable voltage controllers, was supplied by EC&M. Complete computer analysis enabled control equipment to be matched exactly to rotating equipment, helped get production under way quickly.

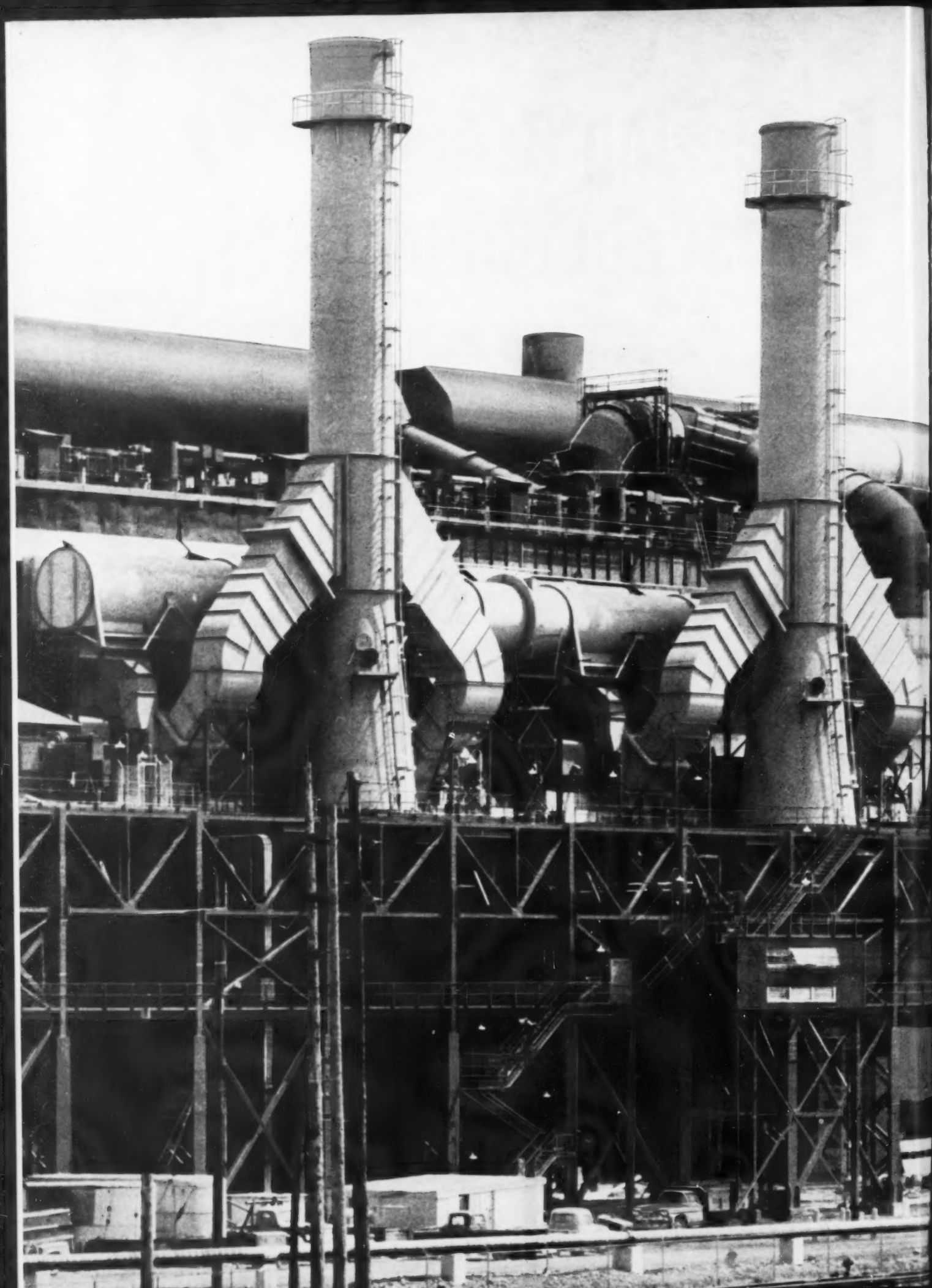


SEND FOR BROCHURE 6609.55

It gives complete details on this installation. Write Square D Company, EC&M Division, 4500 Lee Road, Cleveland 28, Ohio

wherever electricity is distributed and controlled

7065



Oxygen-lance smoke eliminated at J&L Cleveland!

Western Precipitation's experience and "know-how" has solved one of the major problems resulting from the new high production oxygen steel making process—the billowing ore-laden red smoke from open hearths and converters.

The J&L system is a complete turnkey job, handled by WP from preliminary studies, through engineering, construction, and erection to operation. WP-Joy equipment integrated in the package includes electrostatic precipitators, complete flue work, Joy Rotating Diffuser fans, dust handling units, waste-heat boilers, and a complete control system. Total gas flow is approximately one million CFM.

This is another example of complete gas cleaning service to the steel industry by Western Precipitation, the leader in the field—with more successful installations than any other organization.

If you have a dust control problem, WP can solve it. For more information, or an answer to your particular problem, write Western Precipitation Division, Joy Manufacturing Company, 432 Oliver Building, Pittsburgh 22, Pa. (In Canada, write Precipco, 8285 Mountain Sights Ave., Montreal, P.Q.)

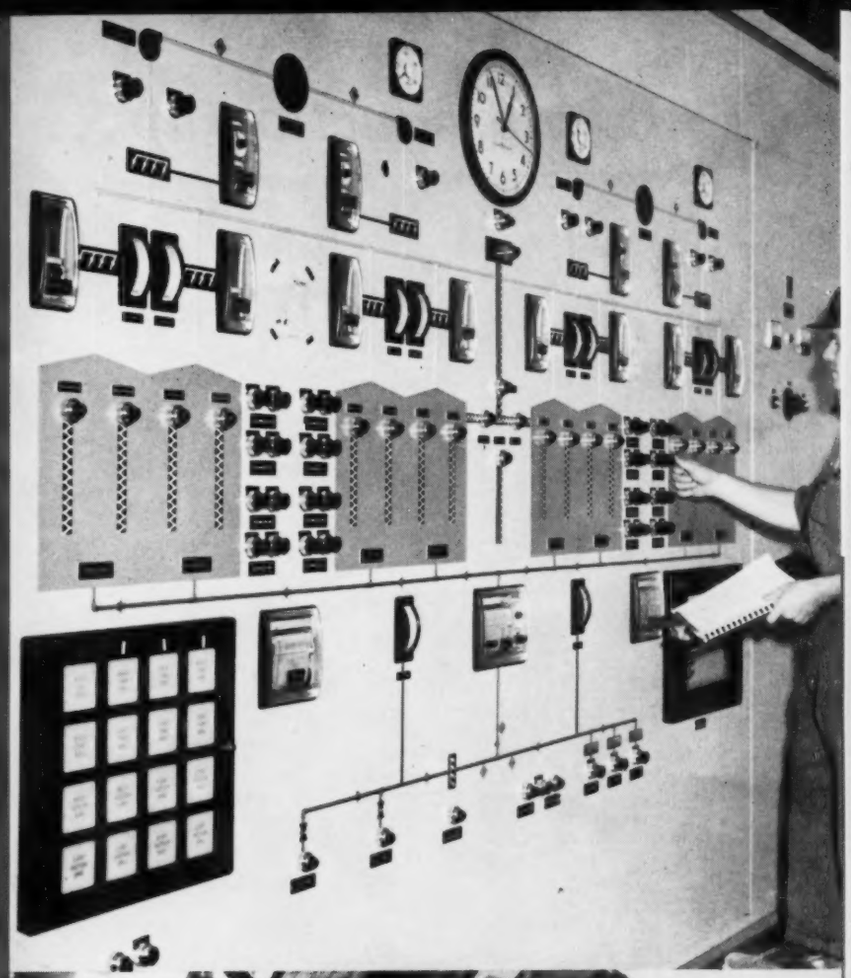
Dust and fume control since 1907

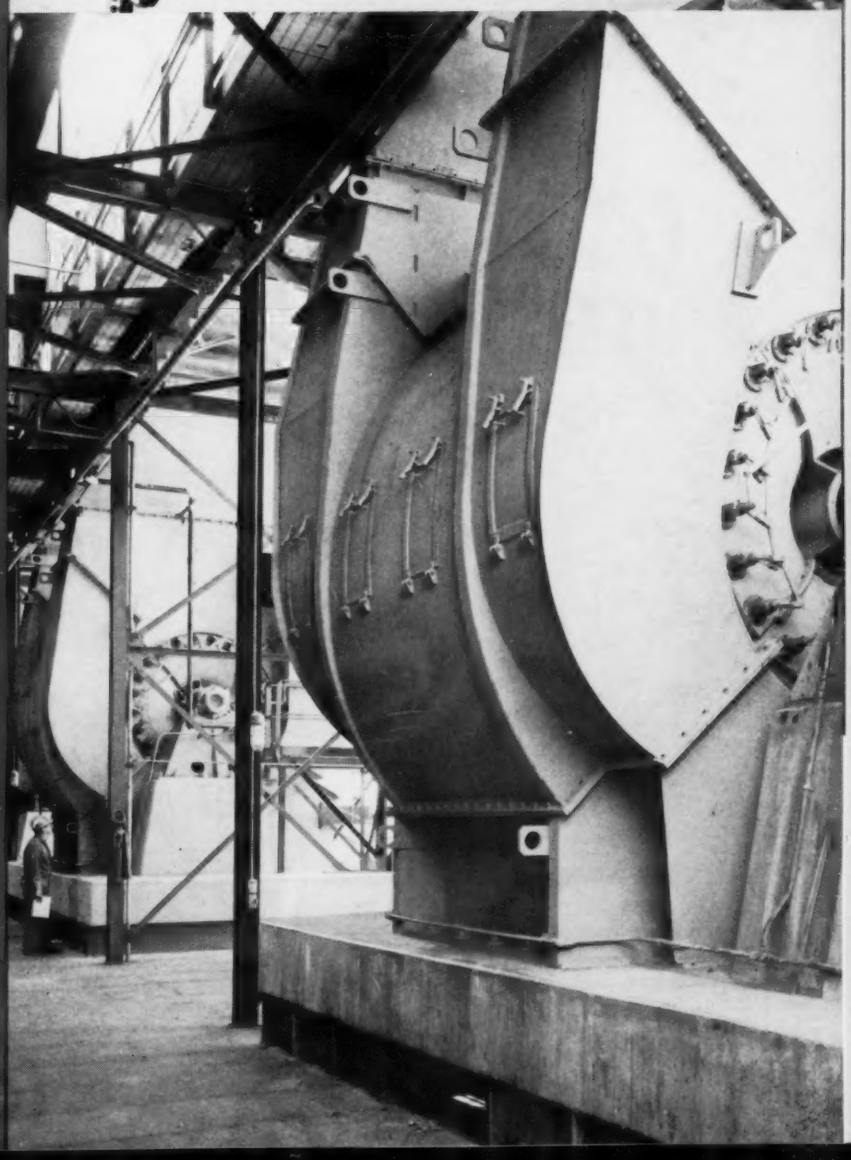
WESTERN PRECIPITATION

Los Angeles 34 • New York 7 • Chicago 2 • Pittsburgh 22 • Atlanta 3 • San Francisco 4

Division of Joy Manufacturing Company

ELECTROSTATIC Precipitators
MULTICLONE Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
THERM-O-FLEX Hi Temp Filters
TURBULAIRE Scrubbers
JOY-MICRODYNE Scrubbers
also: **HOLO-FLITE** Processors
HI-TURBIANT Heaters
TURBULEX Processers



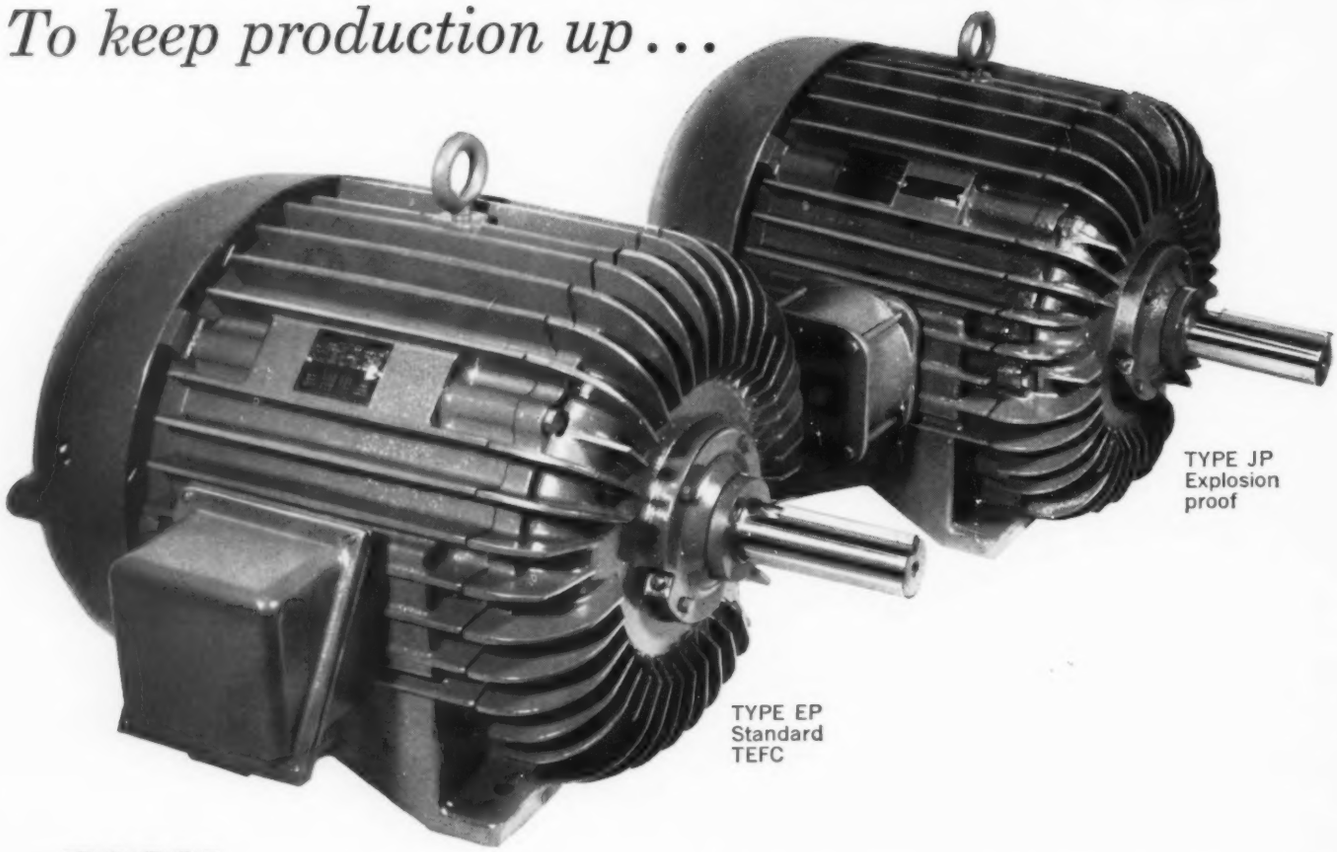


WP precipitator installation (left) towers 15 stories above J&L-Cleveland.

Control console (top right), a marvel of automation, enables one man to control the entire system from one point.

Joy Rotating Diffuser Fans (bottom right), part of the turnkey design by WP.

To keep production up...



TYPE JP
Explosion
proof

TYPE EP
Standard
TEFC

PICK FROM THIS PROTECTED PAIR...

Here's a power-packed pair of Wagner® totally-enclosed fan-cooled motors —Type EP, standard, protected against damage from dust, abrasive, fumes, steel chips or filings; and Type JP, explosion-proof, for safe use in specified hazardous locations.

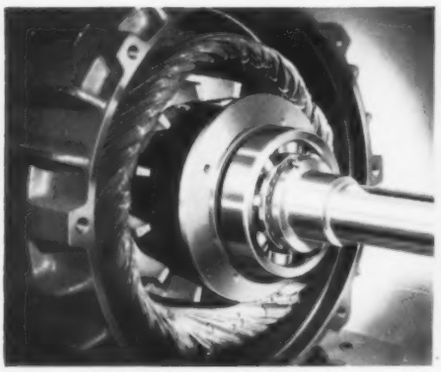
They'll keep your production rates up, delivering full rated horsepower under the toughest conditions . . . staying on the job with dependable, continuous service that means peak output. They're the perfect pick, for individual machines or for automated lines.

In the design illustrated, these motors are built in ratings through 100 hp in NEMA frame sizes 182-445U. Let your Wagner Sales Engineer show you how this protected pair (or larger Wagner enclosed motors through 500 hp) gets the job done. Call him, or write us for Bulletin MU-224.

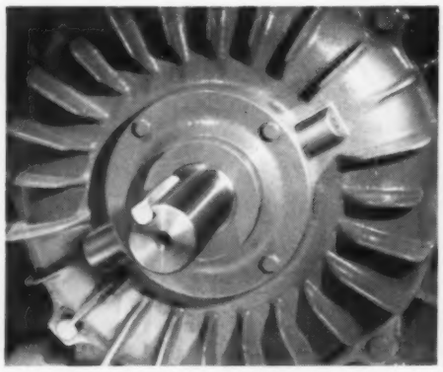
Wagner Electric Corporation

6483 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI

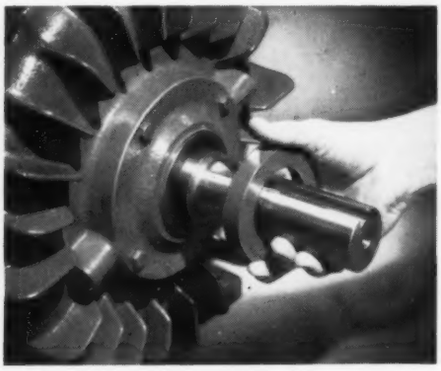
WM60-19



HEAVY-DUTY BALL BEARINGS . . . The ball bearings used in these motors are of the highest quality, with more than ample capacity to provide long, troublefree service under heavy loads.



BEARINGS CAN BE RELUBRICATED . . . Factory lubrication will last for many years under normal service, but openings are provided to permit relubrication that adds years to motor life under severe conditions.

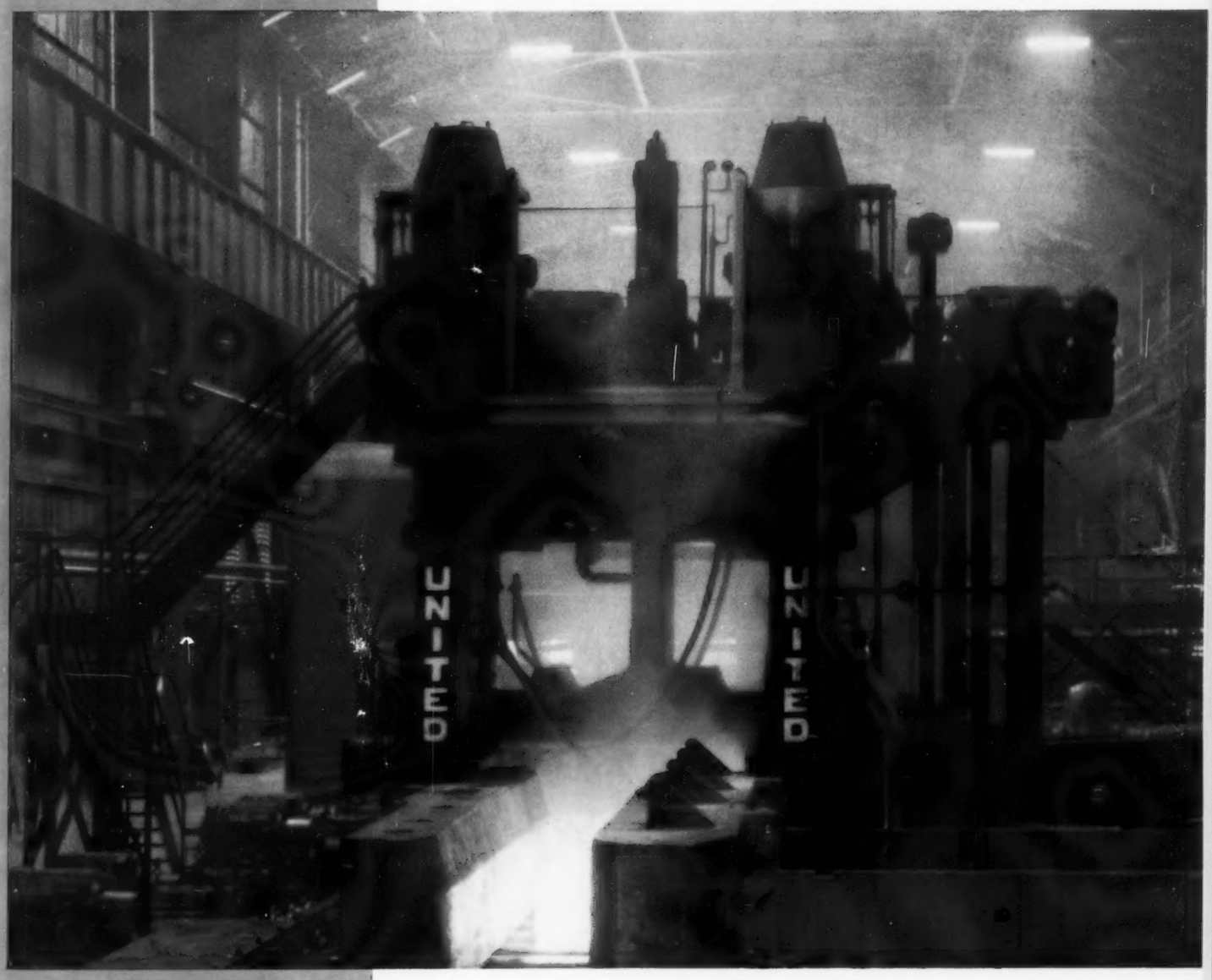


SECURELY SEALED FOR LOW MAINTENANCE . . . Both ends of these motors have running shaft seals to keep the bearings clean. Bearing housings are effectively sealed to prevent escape of grease.

There is a "Service Proved" United Roll for Every Mill Installation

UNITED®

44" x 104"
BLOOMING AND SLABBING
MILL



Plants at Pittsburgh, Vandergrift, Youngstown, Canton, Wilmington

SUBSIDIARIES: Adamson United Company, Akron, Ohio; Stedman Foundry and Machine Co., Inc., Aurora, Indiana

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

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Progress... Leadership United for Sixty Years

The United combination of 60 years of experience, and a continuing program of metallurgical research, sound engineering and modern production facilities, sets the standard for rolling mills, rolls and auxiliary equipment throughout the world.

UNITED
ENGINEERING AND FOUNDRY COMPANY
PITTSBURGH 22, PENNSYLVANIA

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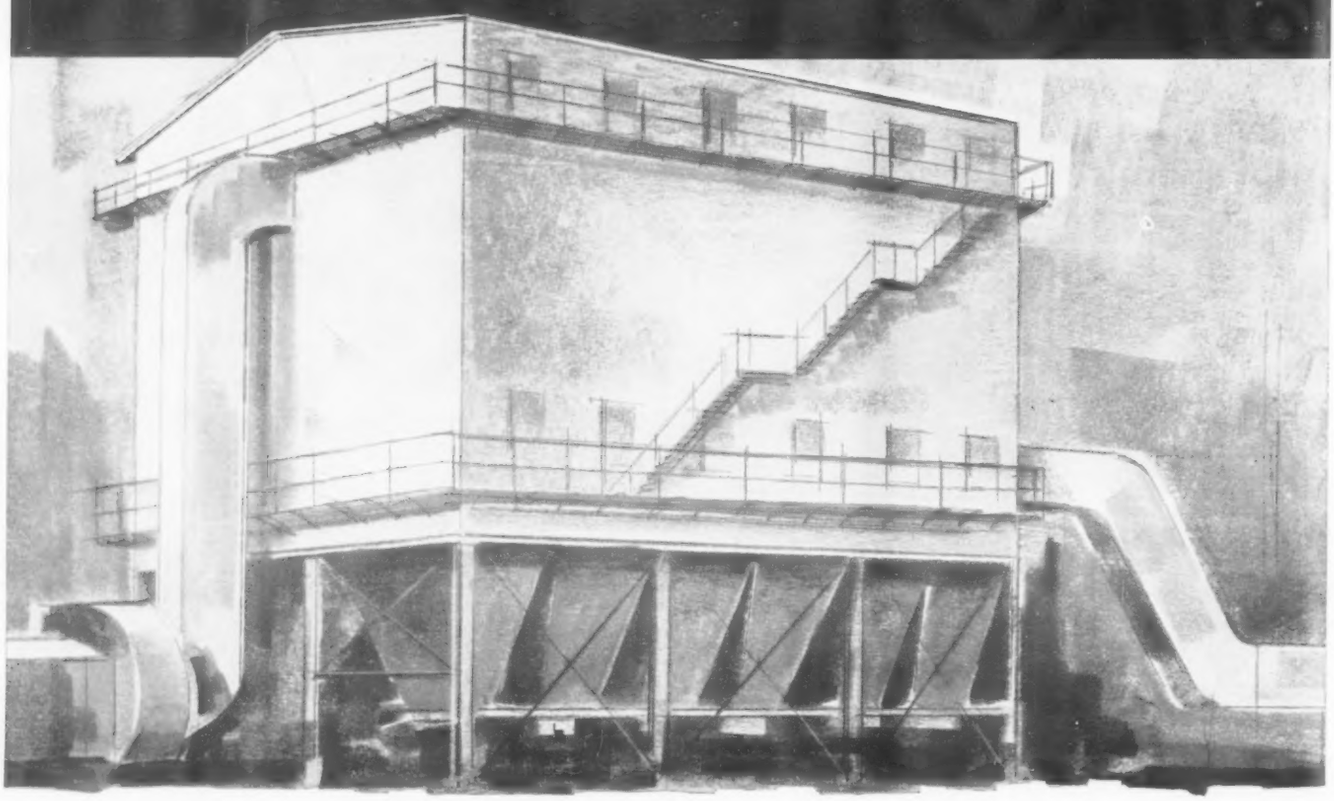

225,000 cfm of hot dusty steel mill air

At a new "big steel" installation, currently under construction, complete dust and fume control will be provided by a Wheelabrator system employing Glastube® filter tubes, in the largest glass baghouse ever engineered for the steel mill industry.

Over 225,000 c.f.m. of air, from this plant's operation, are filtered through the Wheelabrator Dustube Collector, removing all dust and fume particles from the air stream before discharge to atmosphere. The system more than meets all applicable air pollution codes.

Wheelabrator places at your service the industry's broadest experience in application of glass filter tube equipment to high temperature dust and fume problems (up to 550°F) in the steel industry. This is one of the vital values you get only with Wheelabrator dust and fume engineering.

For open hearths, sinter plants, electric furnaces, cupolas, converters.

VITAL VALUES FOR INDUSTRY

WHEELABRATOR
DUST AND FUME CONTROL

WHEELABRATOR CORPORATION, 396 S. Byrkit St., Mishawaka, Indiana. In Canada, WHEELABRATOR CORPORATION OF CANADA, LTD. 1901 Birchmount Rd. P.O. Box 490, Scarborough, Ontario
A subsidiary of Bell Intercontinental Corp.

AT 3 A.M. ON SUNDAY

OUR CUSTOMER HAD TO HAVE A BEARING . . . HE GOT IT FROM 100 MILES AWAY IN LESS THAN 5 HOURS!

That's what we mean by around-the-clock service!

Our branch manager got a call on Sunday at 3 a.m. from his customer. A press, imperative to their operation, was out of service with a broken bearing and a replacement had to be installed in a matter of hours.

Our man checked his branch and found that this was a special bearing which his records showed was in stock at another branch 100 miles away. A call to this branch manager at 4:30 a.m. alerted him to meet a chartered plane at a nearby airport at 6:30 a.m.

We delivered the bearing to our customer at 8:30 a.m. A total elapsed time of less than five hours on a Sunday morning . . .

We are not often called on for such service — When we are, and the need is crucial, you can depend on it — Any one of our many branches can and will go all out to deliver the bearings you need, when you need them!

Get to know our bearings engineers and how they can help you. Call the branch nearest you!

Providing bearing service

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in the South → **DIXIE BEARINGS, INC.**

ARKANSAS: Little Rock • **FLORIDA:** Jacksonville • **GEORGIA:** Atlanta • Augusta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge New Orleans • **N. CAROLINA:** Asheville • Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport Knoxville • Memphis • Nashville • **VIRGINIA:** Norfolk • Richmond • Roanoke

This mark tells you a product is made of modern, dependable Steel.

949 tons of tin product rolled in eight hours on USS Quality Forged Rolls

Not long ago, a crew on the 5-stand cold reduction mill at U. S. Steel's giant Fairless Works rolled out an impressive 949 tons of tin product in a single 8-hour shift.

The mill was equipped with USS Quality Forged and hardened rolls, as might be expected. But you should know that no U. S. Steel mill is obligated to buy rolls from the company if competitive rolls will give better performance. Here is the heart of the story: based on careful long-range performance figures, the USS forged rolls are equal to or better than any other on the market.

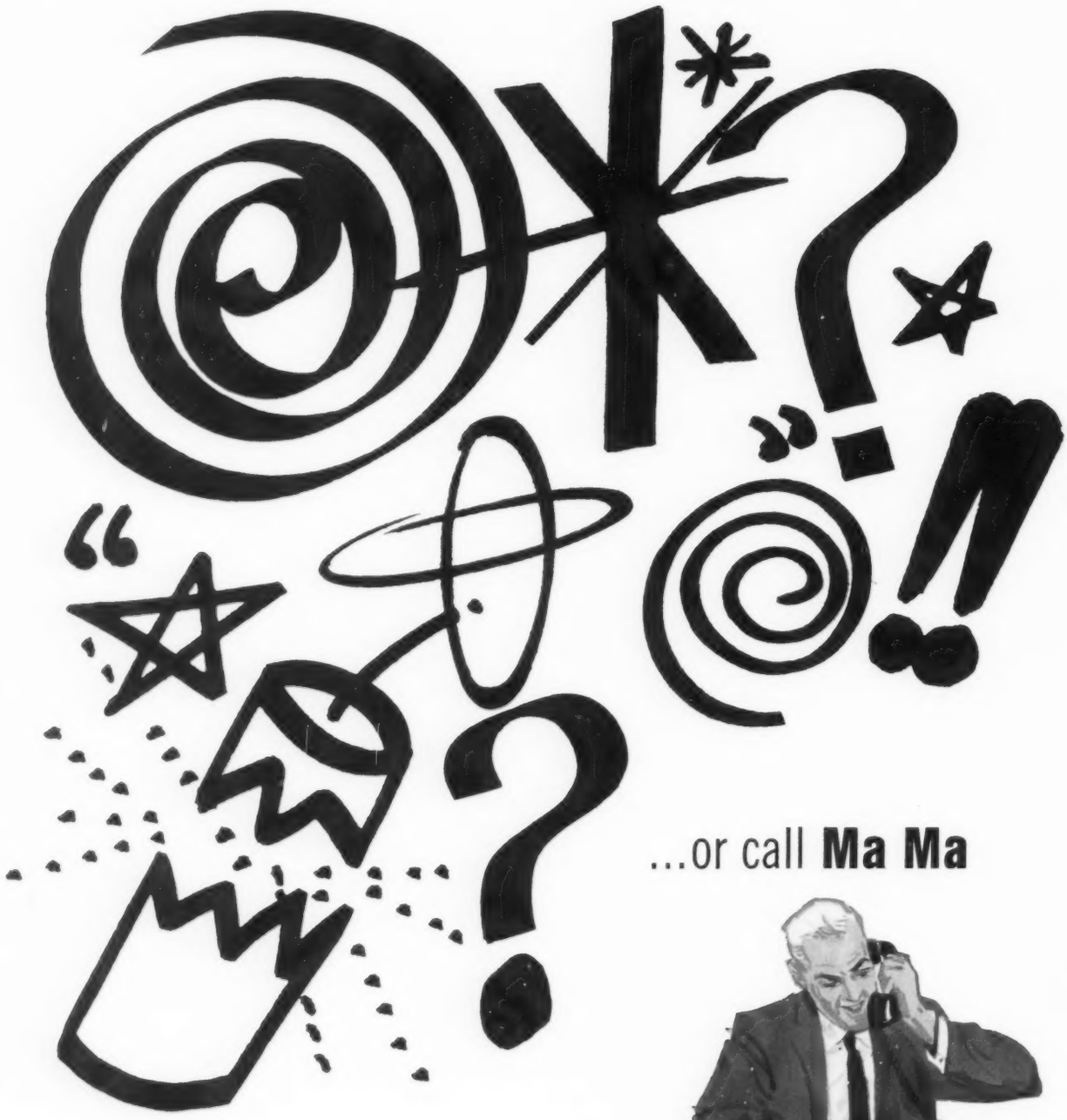
As a major steel producer, U. S. Steel is able to continually test the quality of its rolls. Even further, U. S. Steel buys rolls from other manufacturers—for an evaluation of our product. Over and over again, records have shown that USS Quality Forged Rolls have improved wear resistance, and a high degree of cleanliness.

There is a good possibility that we can help reduce your roll costs. Write or call the United States Steel Office nearest you, or United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation · Columbia-Geneva Steel Division · Tennessee Coal and Iron Division · United States Steel Export Company

USS United States Steel

TRADEMARK



...or call **Ma Ma**

IF A MAN ANSWERS . . . start talking. Talk about your mother-in-law. Your children's braces. Fido's scrofula. Discuss your golf game. Ask why your wife and secretary don't understand you. Then, tell him about your replacement parts problem. Because that's what he can **really** help you with. He's an expert on **any replacement problem related to Mill-Type equipment** ■ Ma Ma wants to bid, from your specifications, on your next equipment need. Ma Ma delivers fast. And spends your money well. Call Ma Ma! Ma Ma is an easy name to remember. It stands for MAchinery-MAintenance Division, Coronado Steel Company. MA MA's phone number is 747-4436.

CORONADO STEEL CO.

MACHINERY•**MA**INTENANCE DIV.
WEST COMMERCE AND NORTH AVE.
YOUNGSTOWN 3, OHIO • PH. 747-4436

Replacement parts: Blast Furnace Parts, Cylinders, Mill Drive Spindles and Couplings, Rolls, Screws, Shafts ■ ACCESSORIES AND TOOLING: Gripper Dies, Pipe Plungers, Shear Blades, Stitcher Punches and Dies, Wear Plates and Liners ■ CUSTOM MACHINERY: Belt Wrappers, Billet Manipulators, Charging and Discharging Equip., Coiler and Uncoiler Mandrel Assemblies, Hydraulic Presses.

LONE STAR BOOSTS CAPACITY AGAIN with MORGAN-ISLEY

Once again Lone Star Steel has turned to MORGAN-ISLEY Systems of Combustion Control for the expansion of their open hearth plant — adding one more MORGAN-ISLEY System to the four now in operation on 250-ton furnaces.

The MORGAN-ISLEY System offers the advantages of faster melting, higher tons per hour, less fuel per ton and less man hours per ton — all reflecting lower operating costs.

Note the big storage area freed for refractory materials and spares — made possible by the installation of MORGAN-ISLEY Systems outside the building. Installation costs are moderate because the foundations can be relatively light as compared to a natural draft system.

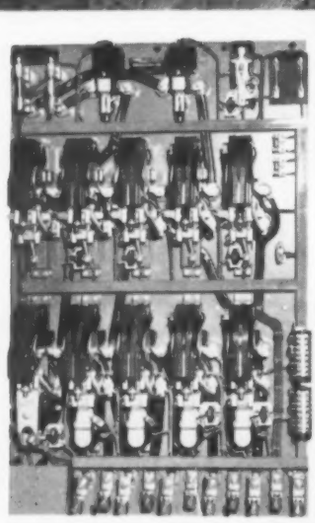
C5

MORGAN WORCESTER

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

ROLLING MILLS • MORGOIL BEARINGS • WIRE DRAWING MACHINES • COMBUSTION CONTROLS



New smaller Cutler-Hammer Bul. 14115 hoist panel featuring front-wired steel panel construction with new unitized Dc contactors, factory wired to easily accessible terminals, and new panel arrangement with all protective devices at the top.

What's new in control for mill cranes?

New Cutler-Hammer Dc crane control with smaller steel panel construction

Here's the smallest area panel on the market today—made possible by Cutler-Hammer's new, unitized Dc contactors. Front wired steel panel construction provides the ultimate in space savings and ease of maintenance. No access to rear of panel is required—all devices are front removable.

New unitized contactors in six sizes (25, 50, 100, 150, 300, 600 amperes) are surface mounted or elevated with spacers for most efficient utilization of panel space. Epoxy resin impregnated coils are completely protected against moisture and dust. Improved blow-out structure increases contact life. Predrilled mounting holes on insulated steel unit bases accommodate interlock assemblies with field convertible contacts.

Check the simple circuitry of the Cutler-Hammer Bulletin 14111 and 14115 crane control. It provides the ultimate in performance with a minimum number of components.

What's New at Cutler-Hammer?

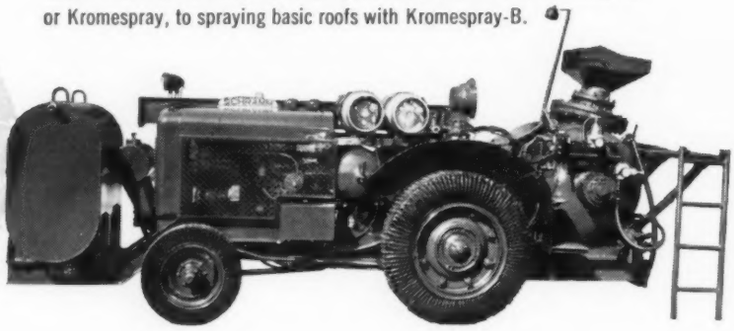
There are many more new and improved products in Cutler-Hammer heavy duty mill control equipment, including the most complete line of mill duty brakes and crane safety limit stops up to 375 hp. For complete details on circuit, mechanical and electrical features, write for Pub. No. LJ-76-W232. Better yet, call your local Cutler-Hammer sales office and ask for a personal rundown on new developments that will improve your crane control.

WHAT'S NEW? ASK...

CUTLER-HAMMER

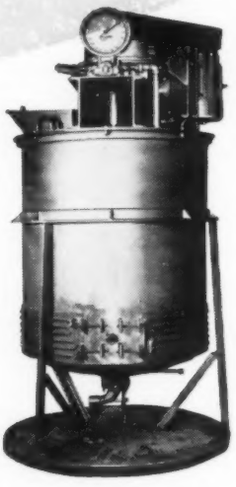
Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Cutler-Hammer Canada, Ltd.; Cutler-Hammer Mexicana, S. A.

THE GREFCO SELF-CONTAINED GUN . . . is a self-mixing refractory gun containing its own compressed air and water supply. This gun is capable of shooting almost any type of refractory material. This versatile unit will perform any open hearth gunning operation—from maintaining frontwalls with Harthmag-10, patching ends or uptakes with Harthmag-10 or Kromespray, to spraying basic roofs with Kromespray-B.



hot or cold–wet or dry

GREFCO has the granular basic refractories and the guns for all types of spray maintenance of open hearth furnaces.



THE GREFCO SLURRY GUN AND MIXER . . . provides a simple, effective means of maintaining basic roofs, skewbacks and backwalls with GREFCO Kromespray-B or D.

GENERAL REFRACTORIES

ROOF SPRAYING . . . in progress with Kromespray-B being applied to the backwall in a large mid-western open hearth, the spraying being done "over the heat" so there is no time loss for this operation.

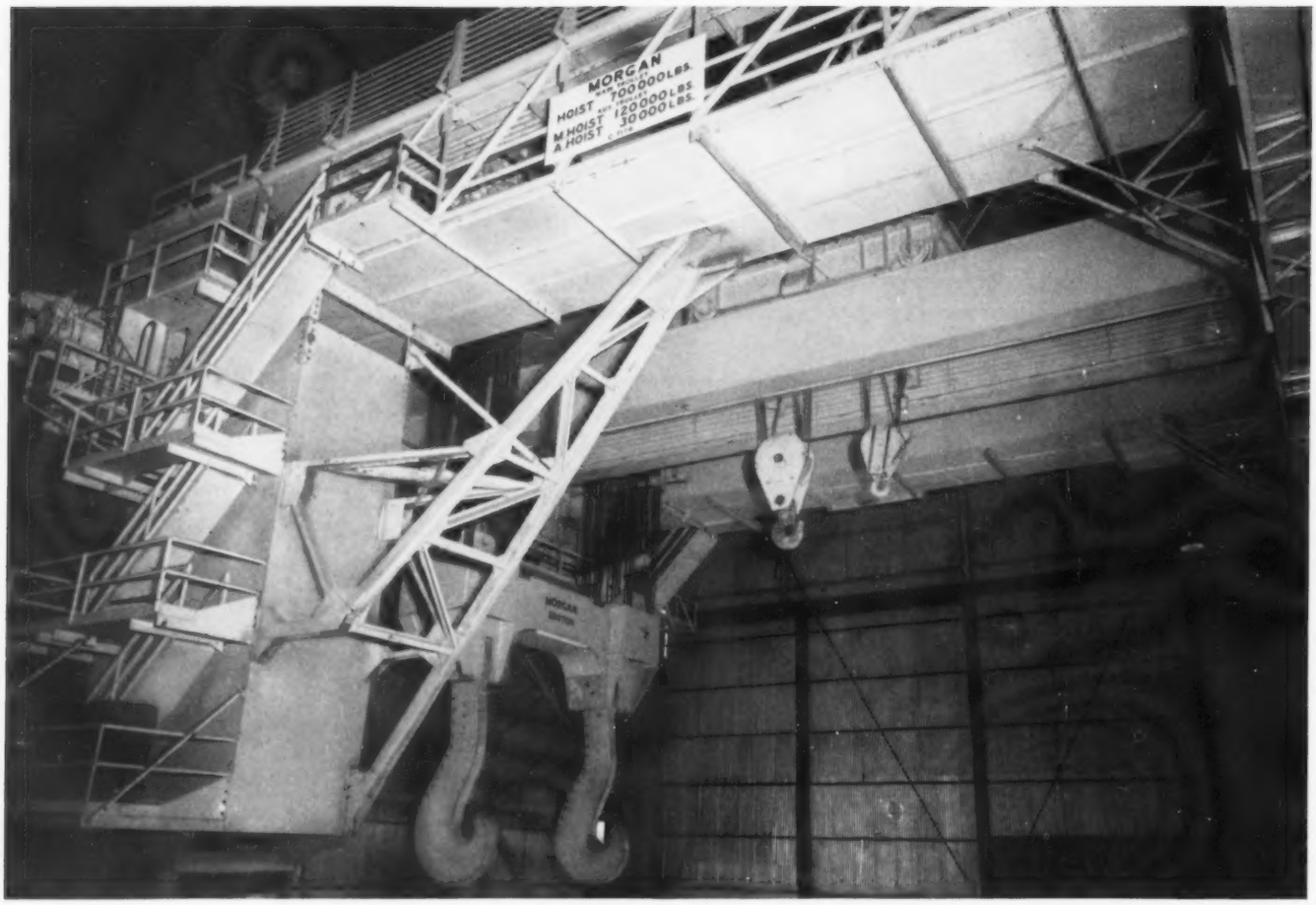
GREFCO GUNNING PROGRAMS GIVE LONGER AND MORE UNIFORM FURNACE LIFE

GREFCO has the equipment, materials, and the experienced personnel to provide exactly the money-saving preventive maintenance program your operation needs. Call your GREFCO representative, today.

GENERAL REFRACTORIES COMPANY
GENERAL OFFICE, 1520 Locust Street, Philadelphia 2, Pa.

DISTRICT OFFICES IN ALL PRINCIPAL CITIES

50th Anniversary
1911-1961

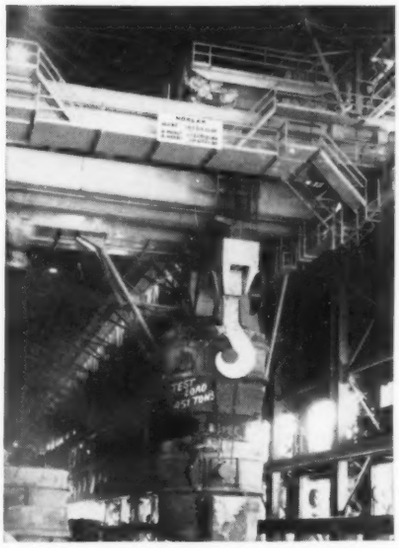


At Granite City Steel...

MORGAN CRANES MOVE THE HEAVY LOADS

This 350/60/15 ton, 67′ span, ladle crane at Granite City, Illinois, demonstrates the extra quality steel companies expect—and get from Morgan. The photo at right shows the same crane undergoing a load test—carrying 451 tons—immediately after installation.

Efficiency and reliability in either mill modernization or expansion result when you have a Morgan Engineering man on your planning team. Call him to get facts on Morgan cranes and other Morgan mill equipment that will help speed production and lower your costs.



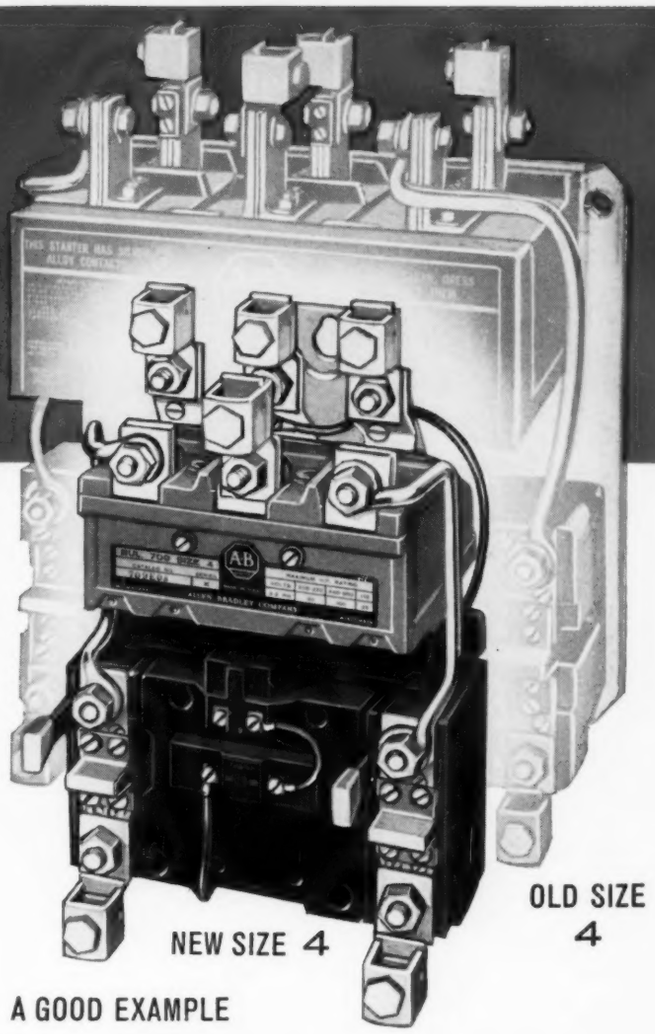
THE MORGAN ENGINEERING CO. *Alliance, Ohio*

Overhead electric traveling cranes, gantry cranes, open hearth special cranes, blooming mills, structural mills, shears, saws, auxiliary equipment and welded fabrications.

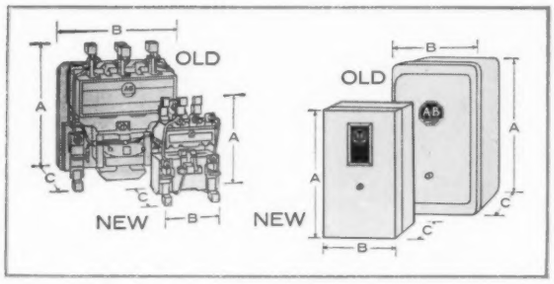
You get BIGGER PERFORMANCE

Plus SMALLER SIZE

with the new Allen-Bradley Bulletin 709 Starters



A GOOD EXAMPLE



The new revolutionary Bulletin 709 motor starters are surprisingly small in size—yet, they are good for many more millions of operations—without trouble or maintenance! Rating for rating, they have no equal. They are today's best starter value—and they cost no more!

The "Quality" you've come to expect in all Allen-Bradley control is represented in all details—especially in the "eye appealing" enclosures styled by the world famous industrial designer, Brooks Stevens. Write today for details of the new Bulletin 709 line—the greatest advance in motor control in 30 years: *Allen-Bradley Co., 1343 South First Street, Milwaukee 4, Wisconsin.*

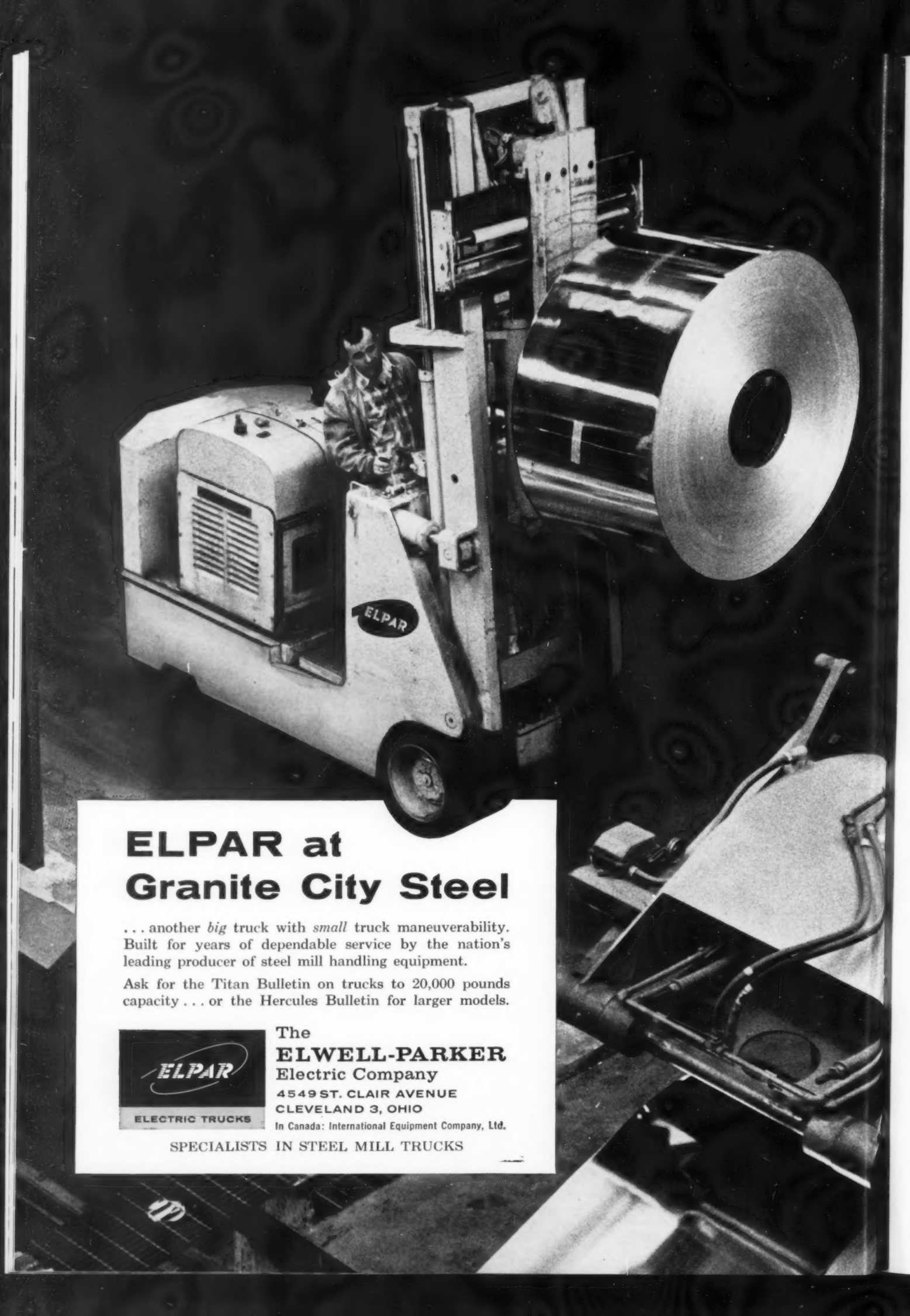
Check These New SPACE-SAVING Dimensions

Starter Size	OPEN TYPE STARTERS						NEMA 1 ENCLOSURES					
	Height A		Width B		Depth C		Height A		Width B		Depth C	
	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD	NEW	OLD
00	4 1/8	—	3 7/8	—	3 1/16	—	7 1/16	—	4 7/8	—	4 1/2	—
0	5 7/8	5 5/8	4 1/8	4 3/4	3 1/16	3 1/4	9 3/16	7 7/8	6 5/16	5 5/8	4 5/8	4 1/4
1	6 5/8	5 7/8	4 5/8	5	3 1/16	3 1/4	10	8 13/16	6 13/16	6 3/8	4 5/8	4 1/4
2	7 5/8	10 1/16	4 5/8	5 3/4	3 1/16	4 7/32	12	14 1/2	7 5/8	9	4 5/8	5 7/16
3	10 1/4	12 5/8	6 1/4	7 1/4	5 7/32	5 7/16	16 5/8	19 1/2	10 3/8	11 3/8	7 1/4	6 1/16
4	11 5/8	16 1/4	7 3/8	12 3/4	6 7/8	6 13/16	22	26 9/16	11 5/8	14 3/16	8 1/4	7 1/16
5	15 3/8	20	9 1/2	16 1/8	8 5/8	8 3/4	32 7/8	41 1/2	17 3/16	19 9/16	10 1/8	13 9/16

ALLEN-BRADLEY

Member of NEMA

QUALITY MOTOR CONTROL



ELPAR at Granite City Steel

. . . another *big* truck with *small* truck maneuverability. Built for years of dependable service by the nation's leading producer of steel mill handling equipment.

Ask for the Titan Bulletin on trucks to 20,000 pounds capacity . . . or the Hercules Bulletin for larger models.

ELPAR
ELECTRIC TRUCKS

The
ELWELL-PARKER
Electric Company
4549 ST. CLAIR AVENUE
CLEVELAND 3, OHIO
In Canada: International Equipment Company, Ltd.

SPECIALISTS IN STEEL MILL TRUCKS

patent reviews

by MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington, D. C., at 25 cents . . . . patents reviewed cover period June 27, 1961 to July 18, 1961

HOT-DIP COATING OF STRIP

△ U. S. 2,989,944, issued June 27, 1961 to Arch W. Harris and Alfred H. Ward and assigned to United States Steel Corp., provides improved apparatus for coating steel strip with aluminum or zinc by a continuous hot-dip process.

One problem often encountered in this operation is that molten coating metal does not properly wet some areas of the strip surface, which thus remain uncoated. Failure of the coating metal to wet the strip is believed due to an oxide film which forms on the surface of the coating bath and tends to cling to strip entering the bath and prevent proper contact between the strip surface and the coating metal. It is known that this tendency can be overcome or at least minimized by moving the strip vertically into a bath, instead of at an angle inclined to the vertical, and by use of mechanical baffles which extend into the bath where the strip enters and prevents the strip from contacting the oxide film.

An object of the present invention is thus to provide an improved baffle construction and mounting which increase the effectiveness of the baffles in preventing strip from contacting and picking up an oxide film and which also overcome any possibility of baffles mechanically damaging the strip surface. The position of the baffles may be adjusted readily as to both their vertical position and their spacing from the strip surface.

In Figure 1, the receptacle 10 contains a bath B of molten coating metal, i.e., aluminum or zinc, heated by any conventional means to maintain it in a molten state. Continuous strip S, i.e., steel enters the bath through a closed chute 12 which extends below the bath surface.

Figure 1

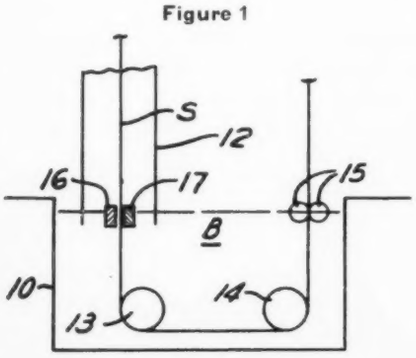
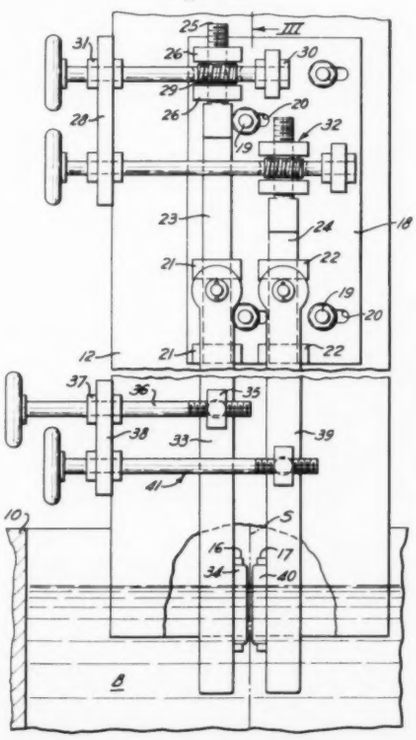


Figure 2



Commonly the strip comes directly from an annealing furnace, not shown, which has a nonoxidizing atmosphere, and the chute protects the strip surface against oxidation as the strip travels between the furnace and bath. The strip travels vertically as it enters the bath and passes around two sink rolls 13 and 14 within the bath and between two coating rolls 15 as it emerges. The strip acquires a coating as it passes through the bath and after leaving continues on to conventional finishing equipment.

The strip passes between two baffles 16 and 17 located at the bath surface within chute 12. The purpose of these baffles is to prevent the strip from contacting and picking up oxide film which unavoidably forms on the bath surface.

The details of the baffle construction are shown in Figure 2.

WIRE VIBRATORY APPARATUS FOR CONTINUOUS PROCESSING LINES

△ U. S. 2,989,942, issued June 27, 1961 to Jack A. Freeman and assigned to United States Steel Corp., provides an apparatus for vibrating wire moving through a continuous wire processing line.

Vibration of wire being processed has proved desirable from the standpoint of improving certain processing operations such as cleaning, pickling, rinsing, coating, etc. It has proved particularly effective in the production of aluminum-coated steel wire by hot dipping. Vibration of the wire moving through a molten aluminum coating bath has resulted

in improved coatings that are more uniform and afford complete coverage of the steel wire. While various forms of wire vibratory apparatus have been proposed for this purpose, trouble has been experienced in obtaining equipment that has a satisfactory life in operation and is not subject to wire-cutting damage by movement of the wire being processed.

This invention accordingly has as one of its principal objects the provision of an improved apparatus that will produce the desired vibration of the wire being processed and has a satisfactory operational life.

Figure 3 shows the invention as used in applying a hot-dipped coating of aluminum to multiple strands of steel wire. It consists of a melting pot 1 containing a bath 2 of aluminum coating metal through which the strands of wire to be coated are drawn. The wire W is fed to the pot 1 over grooved guide rolls 3 and after movement over a sinker 4 is withdrawn vertically through wipers 5.

The apparatus of the invention comprises a wire vibratory drum 6, a frame 7 for supporting the drum 6 and imparting an axial reciprocating movement to it and a drive for rotating the drum 6 and imparting axial reciprocating movement to the frame 7.

OXYGEN REFINING OF PIG IRON

△ U. S. 2,991,173, issued July 4, 1961 to Bernard Trentini and Pierre Vayssiere, assigned to Institut de Recherches de la Siderurgie Francaise, provides a method of refining pig iron by oxygen blowing.

As shown in Figure 4, the converter vessel 1 contains liquid pig iron 2. An injection pipe or lance 3 introduces oxygen which will penetrate molten pig iron 2 and which refines it. The jet of oxygen gas is indicated by numeral 4. Part of the oxygen will oxidize carbon contained in the metallic bath and will form gas bubbles 5 consisting essentially of carbon monoxide. The gas bubbles 5 will pass up through the molten pig iron 2 and will emanate at the upper surface of molten pig iron 2.

A conduit 6 introduces powdered iron oxide or lime suspended in a stream of oxygen into two conduits 9 and 10 from which streams 7 and 8 will emanate.

Due to their inertia, the powdered particles in streams 7 and 8 will preserve, to a large extent, their initial velocity and thus will be able to penetrate the surface of the liquid pig iron bath 2. On the other hand, the speed of the gas stream leaving introducing pipes 9 and 10 will be sufficiently slow and the distance between the orifices of conduits 9 and 10 and the surface of the bath 2 of molten pig iron will be sufficiently great, so that the gas streams 7 and 8 will not be able to penetrate the surface of the molten pig iron bath 2.

Thus, commercially pure oxygen, used as carrier for the suspended powdered ore in conduit 11 leading to distributor 6 and introduction conduits 9 and 10, will form a combustion supporting gas which will oxidize carbon monoxide, in the lower portion of streams 7 and 8, to carbon dioxide. It is important that the gas streams 7 and 8 be capable of oxidizing the carbon monoxide and thus release the heat which will be transferred to the powdered material within gas streams 7 and 8 and by such powdered material into the bath of molten pig iron. In the region adjacent to the upper surface of the bath of molten pig iron 2, the powdered ore or lime carried by streams 7 and 8 will reach a high temperature due to the great amount of heat generated in this region by the combustion of carbon monoxide and thus a considerable number of calories will be introduced into the molten pig iron by the particles of streams 7 and 8 when these particles penetrate the surface of the bath of molten pig iron.

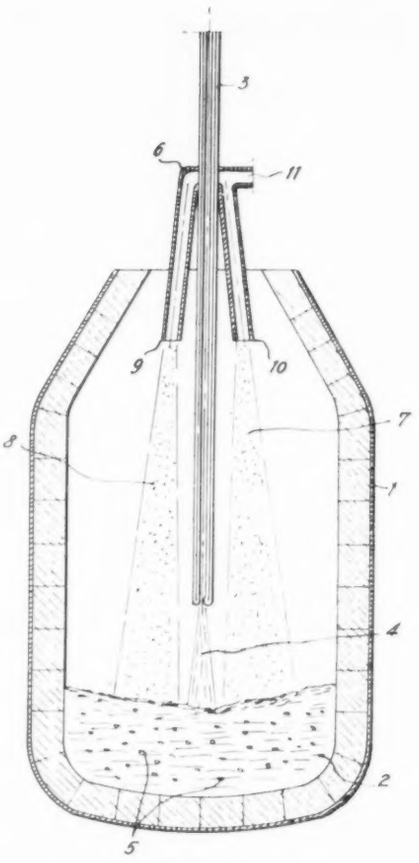
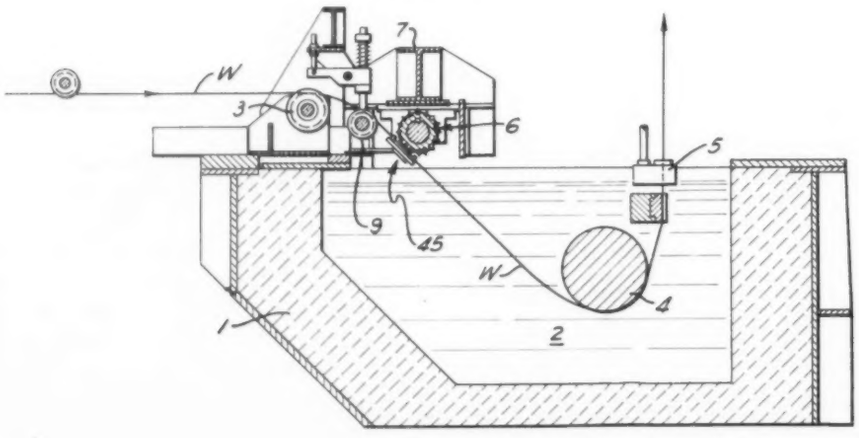


Figure 4

Figure 3



DESULPHURIZATION OF IRON AND STEEL

△ U. S. 2,992,097, issued July 11, 1961 to Harry R. Spence, relates to the desulphurization of iron and steel in furnaces.

It has been found that ferrous metals can be more effectively desulphurized by introducing into the molten bath of ferrous metal a stream of molten caustic soda together with an additive consisting of calcium carbide, manganese dioxide, magnesium oxide, calcium boride, a rare earth oxide, calcium cyanamide or fluorspar. In addition to desulphurizing the molten ferrous metal this imparts improved physi-

OUTSIDE—covered with an abrasive sintered iron ore mix, dust and dirt.

INSIDE—completely free of contamination! Still full of grease.

STILL TURNING FREE AND EASY

after 4 rugged years ...without regreasing

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This is only one of several Link-Belt standard production idlers that have logged 31,616 hours of service in four years at a steel mill. Others are still operating. When removed, this idler had made 364,216,320 revolutions, handled 11,065,600 tons of sintered iron ore mix . . . one of the most abrasive compounds known to industry. And it did it with the *original factory grease*. Link-Belt welded shut the grease fittings to prevent regreasing.

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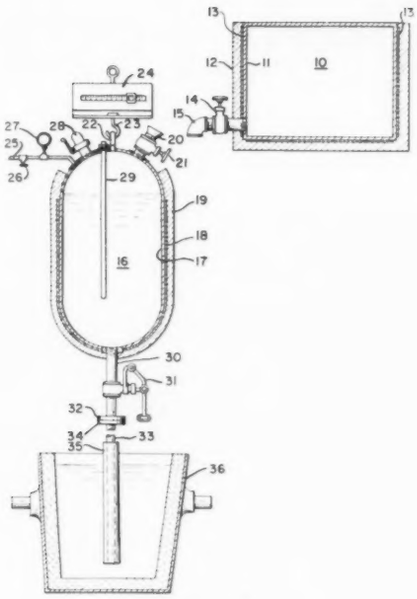


Figure 5

cal properties, particularly greatly improved tensile strengths.

Figure 5 shows a salt melting and storage pit 10 in which the mixture of caustic soda and additive are fused and held. The pit 10 is made up of an inner steel shell 11 and an outer unit insulator 12 between which are placed strip heaters 13 used to heat and hold the fused caustic at the desired temperature. The fused mixture is delivered from the pit 10 through an outlet valve 14 and nozzle 15 into a delivery capsule 16 made up of an inner steel shell 17 surrounded by strip heaters 18, all enclosed by unit insulation 19. The molten caustic is delivered from the nozzle 15 of the pit through an inlet tube 20 and valve 21 on the capsule 16. The capsule 16 is suspended on a ring 22 fixed to the shell 17. Preferably the ring 22 is suspended on a hook 23 from a weighing device 24. An air pressure inlet line 25 communicates through a valve 26 to the interior of the capsule 16. A pressure gage is provided in the line 25 to indicate the pressure within the capsule 16. A relief valve 28 is provided to vent the capsule in the event that excess pressures are built up. A pyrometer well 29 extends vertically from the shell 17 into the interior of the capsule 16. An outlet line 30 is provided in the bottom of the capsule 16 communicating with the interior of the shell 17. This outlet line 30 is provided with a high-speed clip valve 31 and a quick-opening flange 32. A steel lance 33 provided with a mating quick-opening flange 34 is attached to flange 32. Preferably, an outer protective shell 35 of carbon or other refractory material covers the lance 33. The lance is adapted to extend into a ladle 36 or furnace in which the ferrous metal to be treated is held.

In operation, the capsule 16 is loaded from the pit 10 to inlet line 20 and valve 21. Air is applied to the interior of the capsule through the line 25 until a desired pressure is achieved. The capsule is then transferred to the area of the molten bath to be treated. The lance 33 is inserted in the molten bath, valve 31 is opened and the air pressure forces the fused mixture of caustic and additive into the bath until a desired amount as indicated by the scale 24 has been delivered to the bath at which point valve 31 is closed and lance 33 removed from the molten bath.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,990,135	6/27/61	Adjustable pay-off reel	United States Steel Corp.
2,990,268	6/27/61	Pelletized iron ore concentrate	Fred D. DeVaney
2,990,272	6/27/61	Desulphurizing molten iron	Allegheny Ludlum Steel Corp.
2,990,275	6/27/61	Hardenable stainless steel alloys	Union Carbide Corp.
2,991,060	7/ 4/61	Reverberatory metal melting furnace	Wenzeslaw F. Sklenar
2,991,172	7/ 4/61	Reduction of iron ores containing ferruginous clays	Pakistan Council of Scientific and Industrial Research
2,991,174	7/ 4/61	Production of chromium steel	Chromium Mining & Smelting Corp., Ltd.
2,991,205	7/ 4/61	Improving corrosion resistance of stainless steel	Allegheny Ludlum Steel Corp.
2,991,549	7/11/61	Fabrication of plastic-clad steel	Lukens Steel Co.
2,992,096	7/11/61	Refining of steel	Heber J. Hamlet
2,992,148	7/11/61	Alloy steels	The International Nickel Co., Inc.
2,992,950	7/18/61	Malleable cast-iron compounds	Regie Nationale des Usines Renault

SOUNDING ROD SEAL FOR A BLAST FURNACE

△ U. S. 2,992,486, issued July 18, 1961 to Helmer A. Ruth and assigned to Interlake Iron Corp., provides a sounding rod seal for a blast furnace.

As shown in Figures 6 and 7, the sounding rod seal assembly is slidably disposed in a tube 14 and which has replaceable thermoplastic cup seal packings 36 adapted for sliding sealing engagement with the inner longitudinal wall of the tube. The seal assembly includes a cylindrical member A having flanges 30 and 44 on its ends. The packings fit over and encase the flanges and are detachably secured to them. Means are provided at each end of the seal assembly for securing it to the test rod flexible cable 16. With this construction, an effective seal is provided enabling quick and simple replacement of the sealing medium.

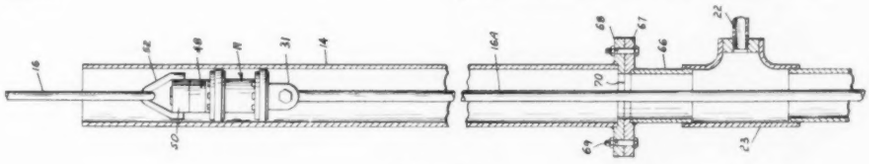
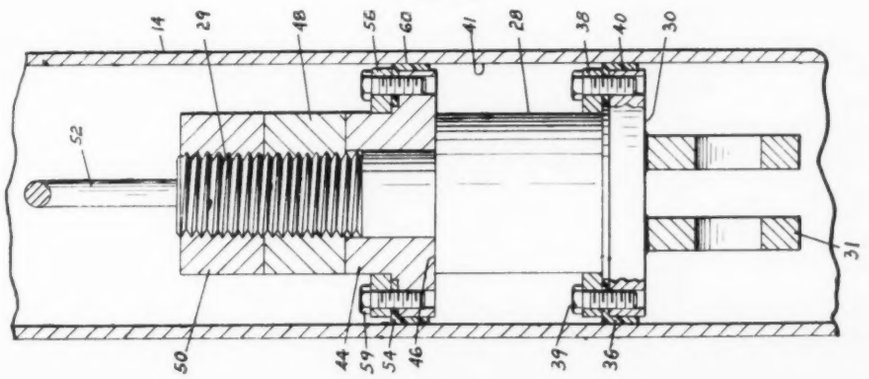


Figure 6

Figure 7



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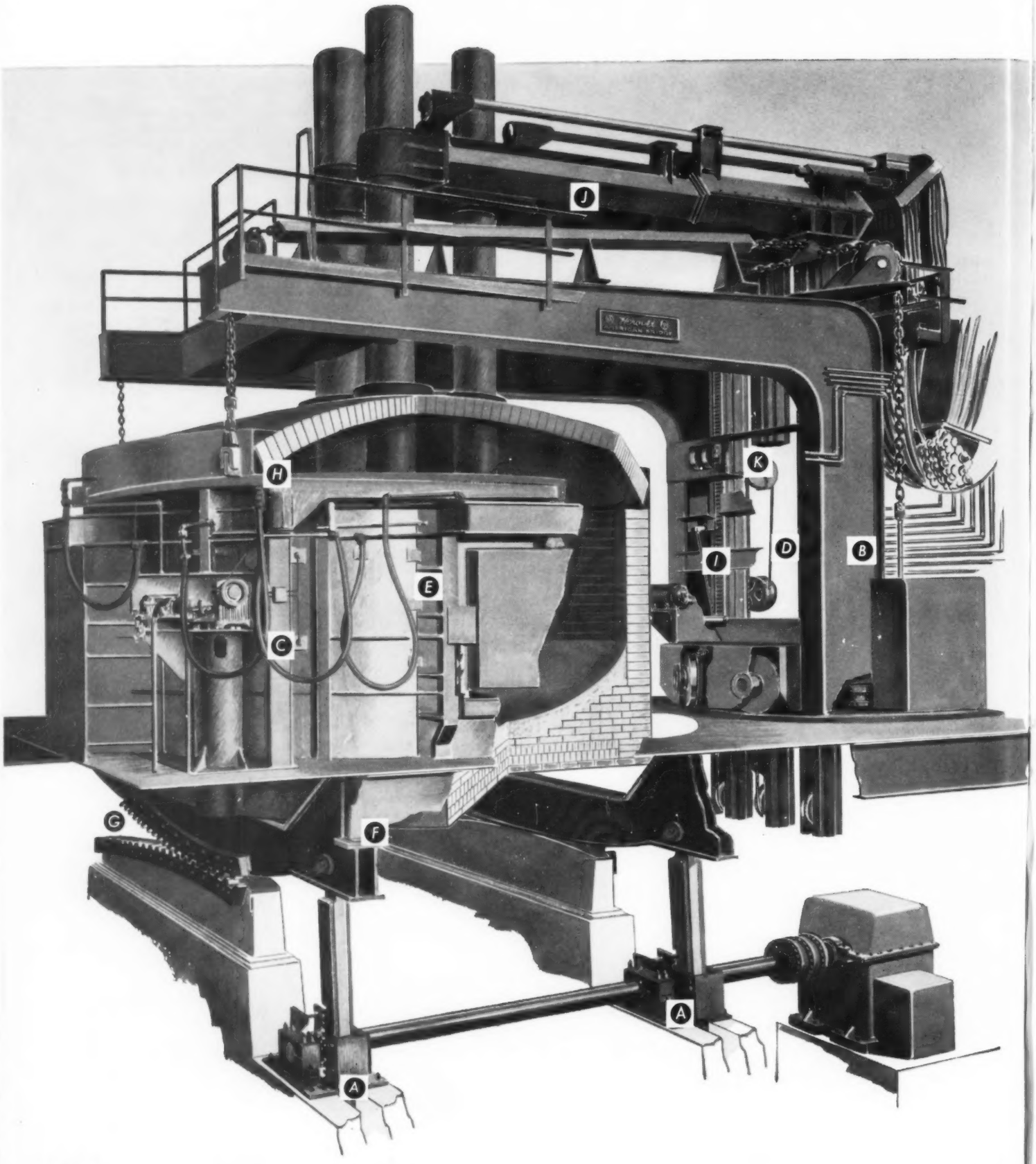

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If you're looking for performance, efficiency, economy and low-cost maintenance, consider these features:

1. Heroult Furnaces are 100% mechanically operated. Including **(A)** heavy rack-and-pinion-type tilting mechanism, **(B)** motor-driven, rotating, jib-type roof swing, **(C)** winch-operated, water-cooled, jib-type door-lift mechanism, and **(D)** high-speed, electro-mechanical electrode-positioning mechanism.

2. Cage-type shell construction with shell plates loosely attached **(E)** to heavy supporting structure. This construction minimizes shell warping and allows easy replacement of damaged shell plates.

3. Operating mechanism independently supported. The tilting platform on which all operating mechanisms are supported is attached directly to the rockers independent of the shell structure **(F)**. Thus, operating mechanisms are unaffected by shell distortion.

4. Water-cooled, Skew Back Roof ring. This feature **(H)** eliminates the need for special skew-shaped roof refractories.

5. Electrode Mast Safety Device. This spring-loaded, rack-and-pawl-type device **(I)** provides positive protection against damage resulting from electrode winch cable breakage.

6. Square-section, Water-Cooled Electrode Mast Arms. This design **(J)** guarantees a rigid connection between mast and mast arm, thus helping to maintain proper electrode position.

7. Remote-Controlled Electrode Clamps. This device, of the spring-clamp, air-release type, is located inside of the rear section of the water-cooled mast arm where heat cannot affect it.

8. Square-Sectioned Electrode Mast. This design feature **(K)** developed by American Bridge, assures proper guiding and electrode positioning.

9. Rockers. The heavy fabricated steel curved top and bottom rockers **(G)** minimize forward travel during tilting. These rockers are designed so that the furnace will tend to return to horizontal position from any degree of tilt.

American Bridge constructs Heroult Furnaces for all types of arc melting, in charge capacities from 6,000 lbs. to 400,000 lbs. with shell sizes ranging from seven feet up. They are equipped with roof-removing mechanism for fast top charging. They can be furnished with a non-magnetic shell bottom section to accommodate induction-stirring equipment. Gantry-type top-charge furnaces, door-charge furnaces and special furnaces for duplexing and non-ferrous melting are also available. Your crew can easily maintain a Heroult Furnace. Check American Bridge's complete design, construction and installation service.

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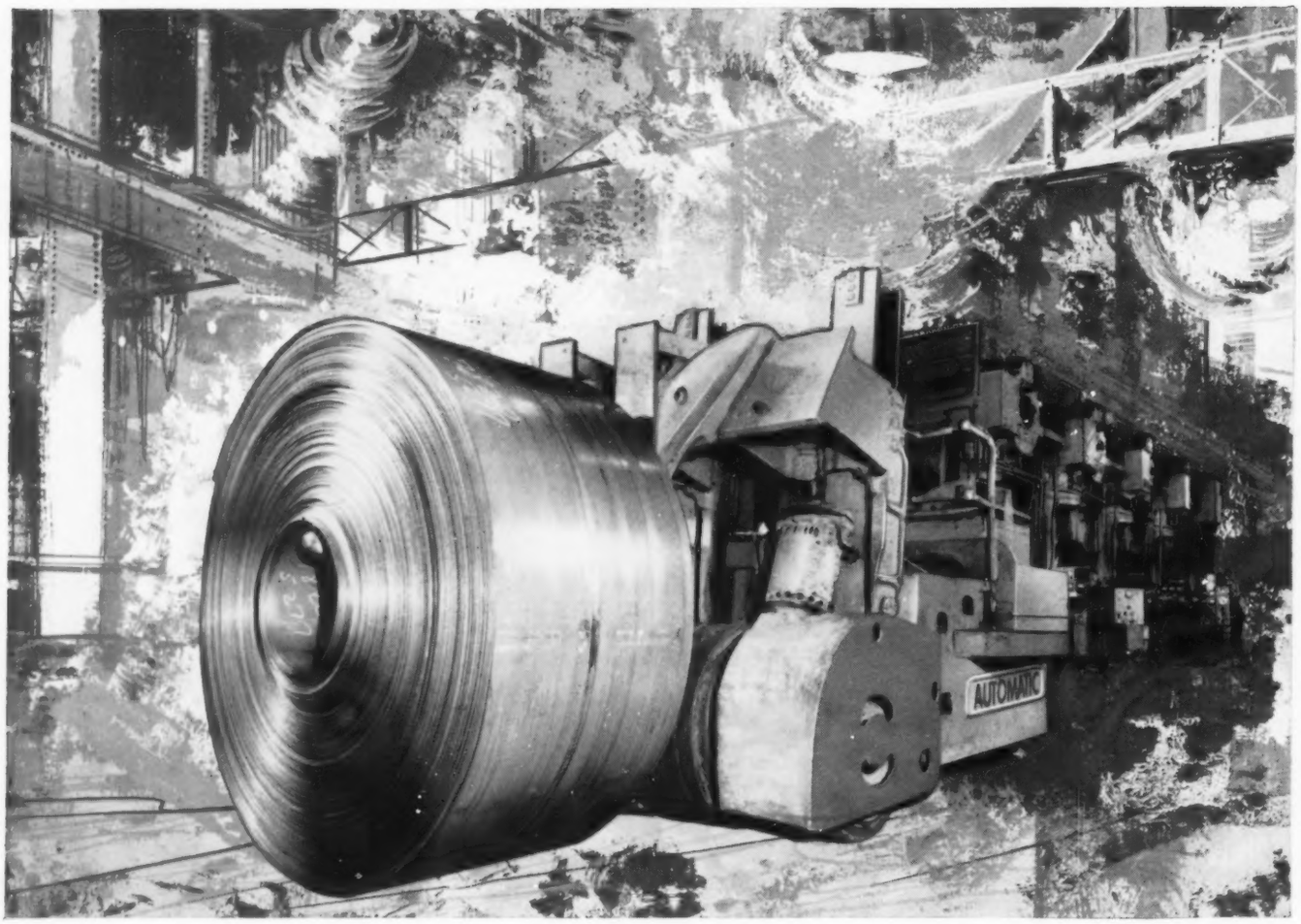

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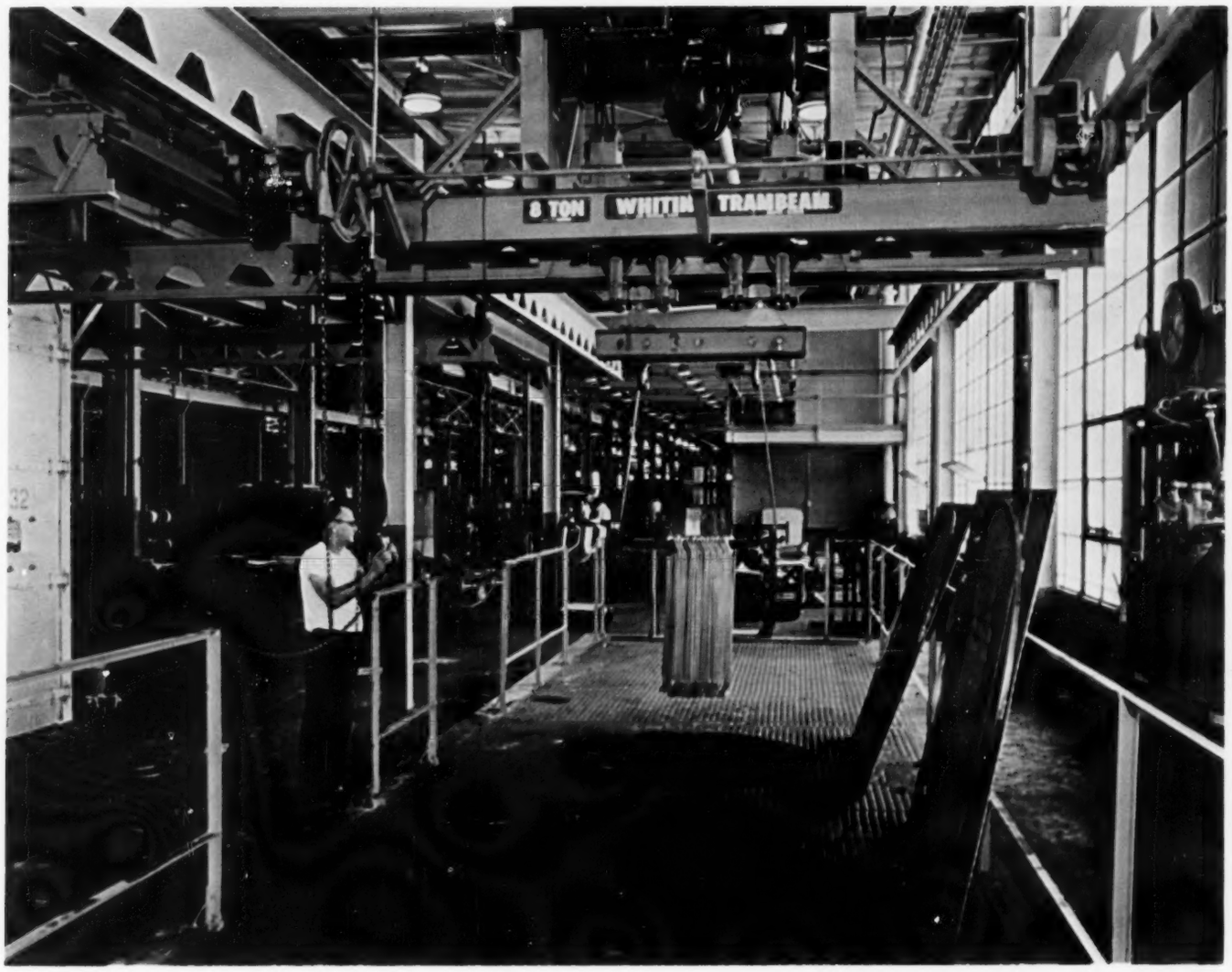

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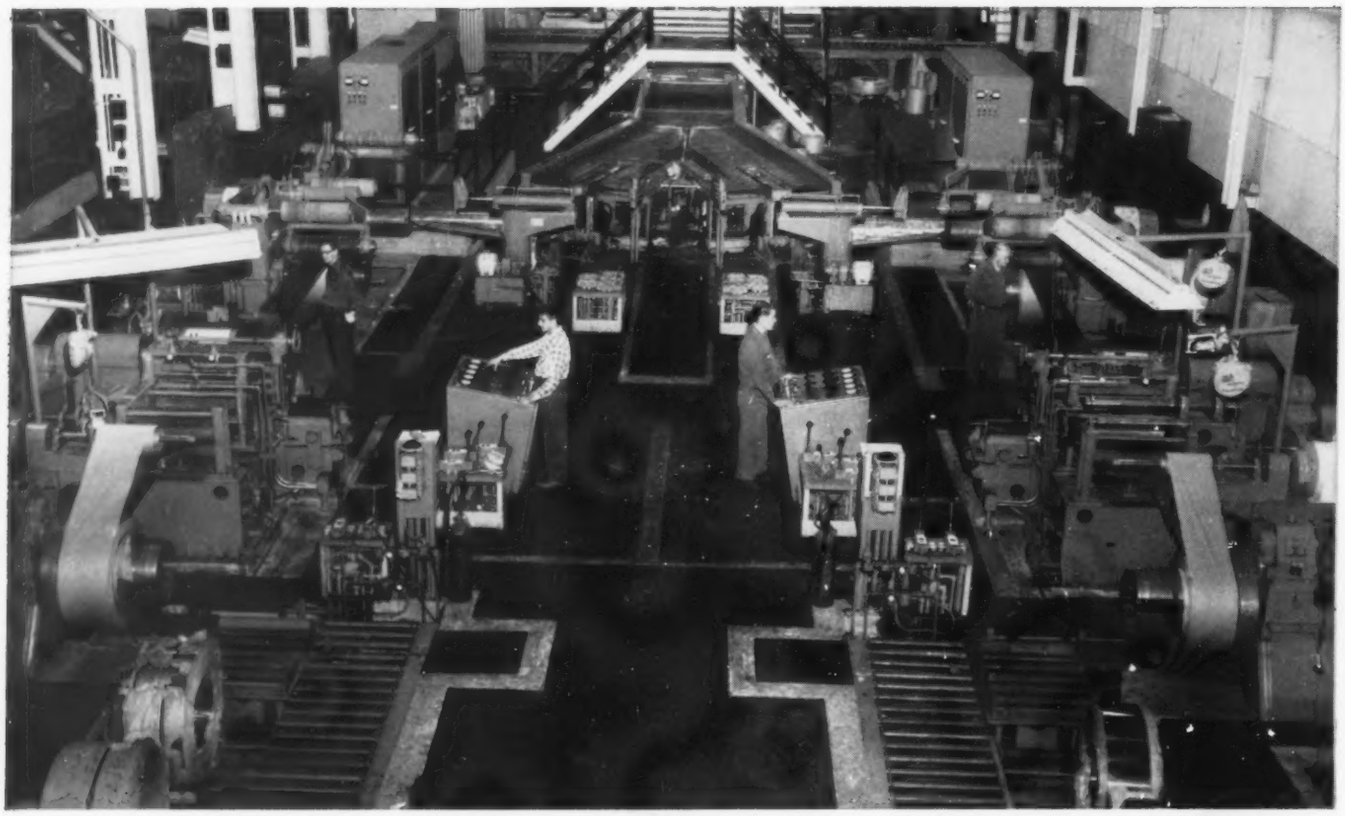

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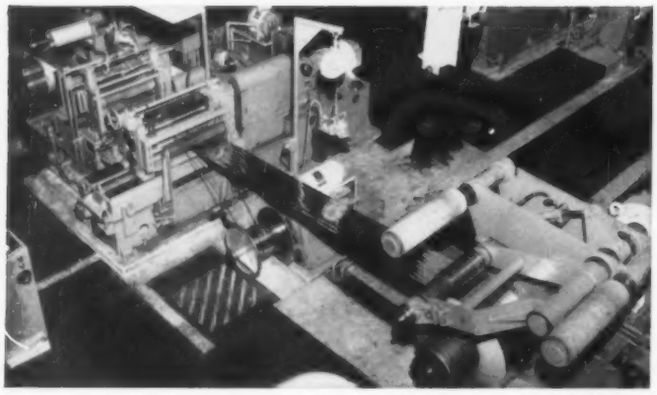

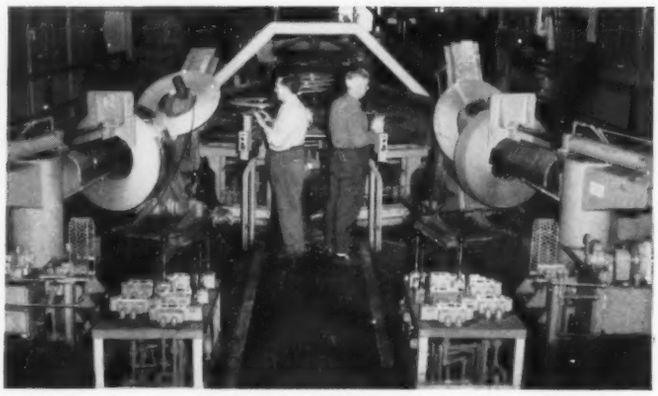

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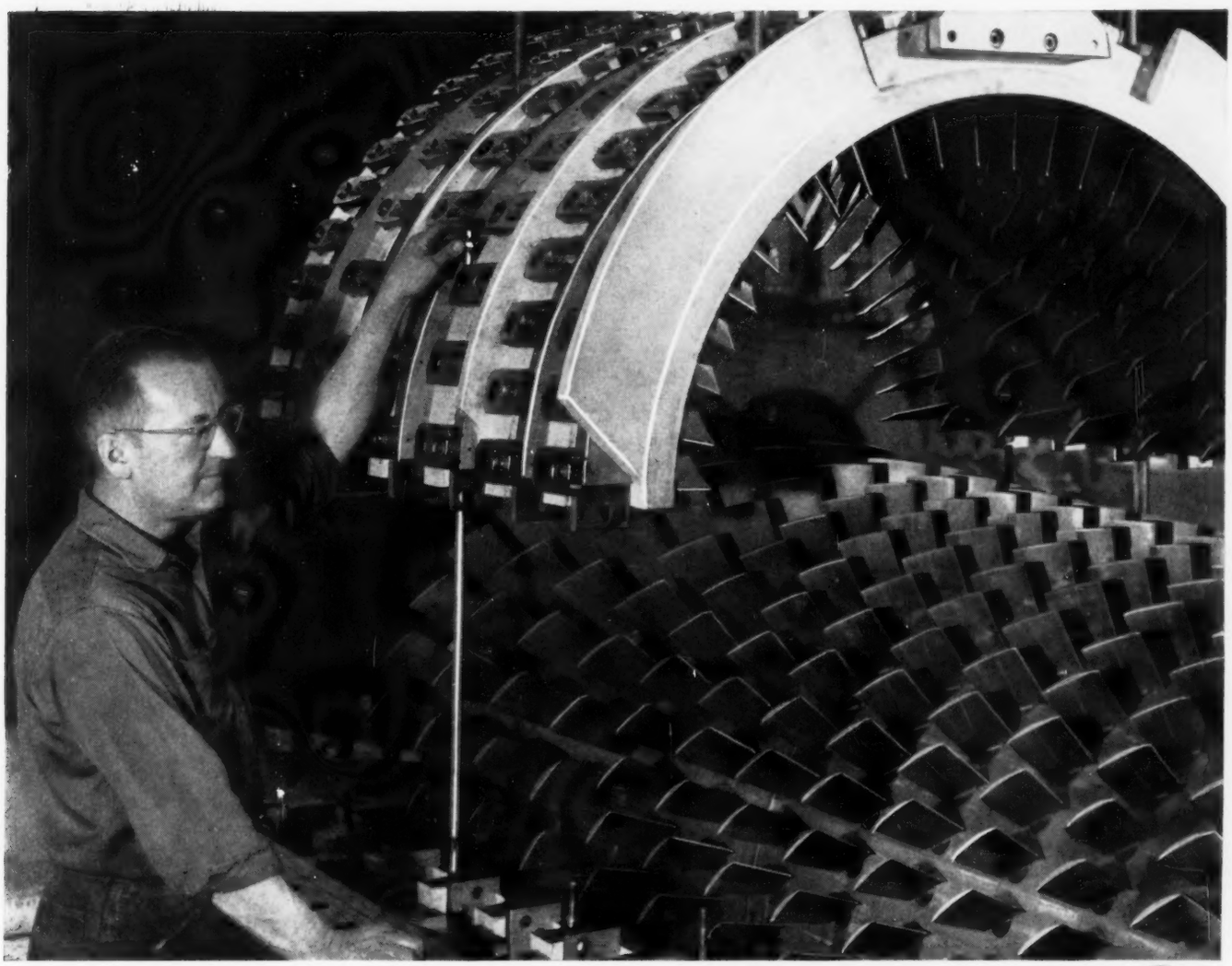

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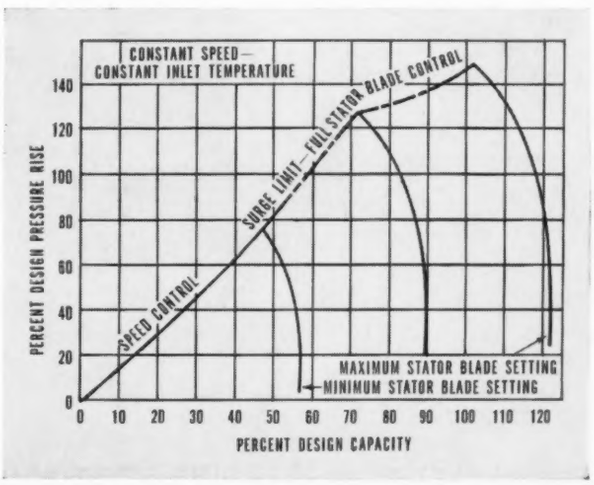

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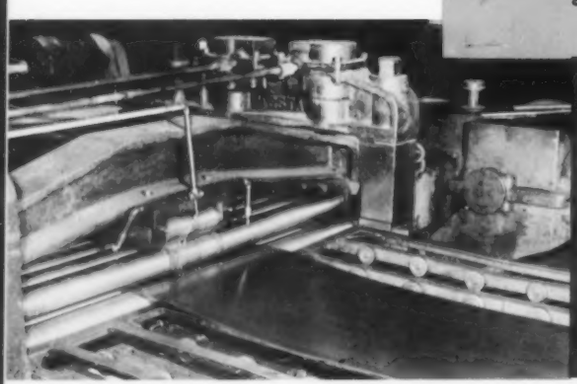
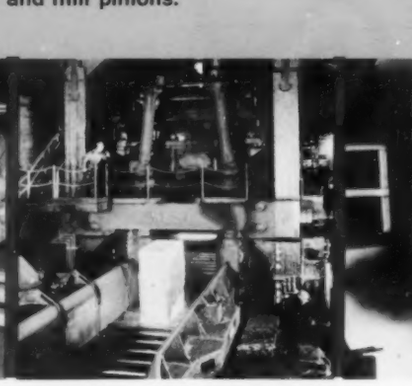
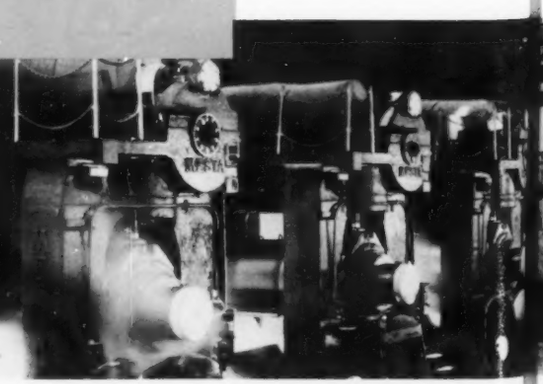


▲ TSP leveller rolls deliver extra long life.



▲ TSP screwdown screws, window plates, rolls, and gears on slabbing mill.



▲ TSP edger gearing on hot strip mills.

CORPORATION DOES !

All TSP products are hardened by our special process. The file hard surface to the full depth of permissible wear gives maximum life. The core, refined for toughness and ductility, gives maximum strength. You receive a written guarantee that TSP products will wear longer in the same service than any other competitive hardened product.

Write today—see how TSP products can save money for you.

THE
TOOL STEEL
GEAR & PINION
COMPANY

CINCINNATI / OHIO / USA

MEMBER OF AGMA

the standard of quality since 1909 for gears ■ pinions ■ rolls ■ wheels and other hardened products.

AD 1047-A

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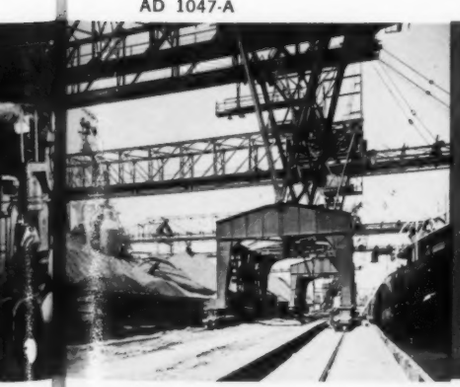
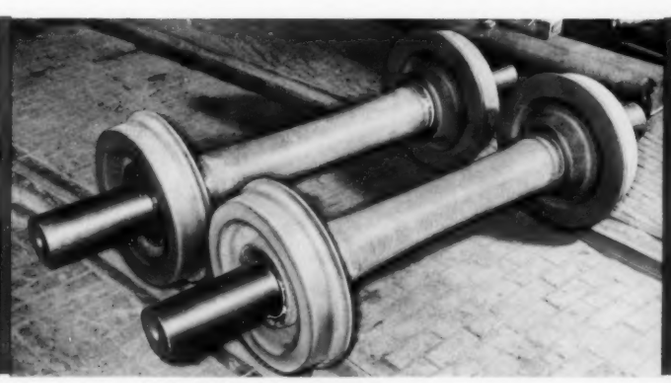
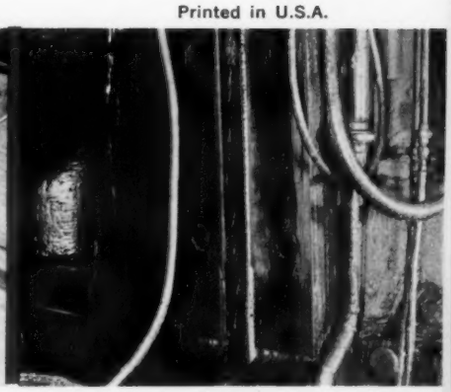


▲ TSP track wheels, spur and herringbone gears, sheave wheels on ore bridges.



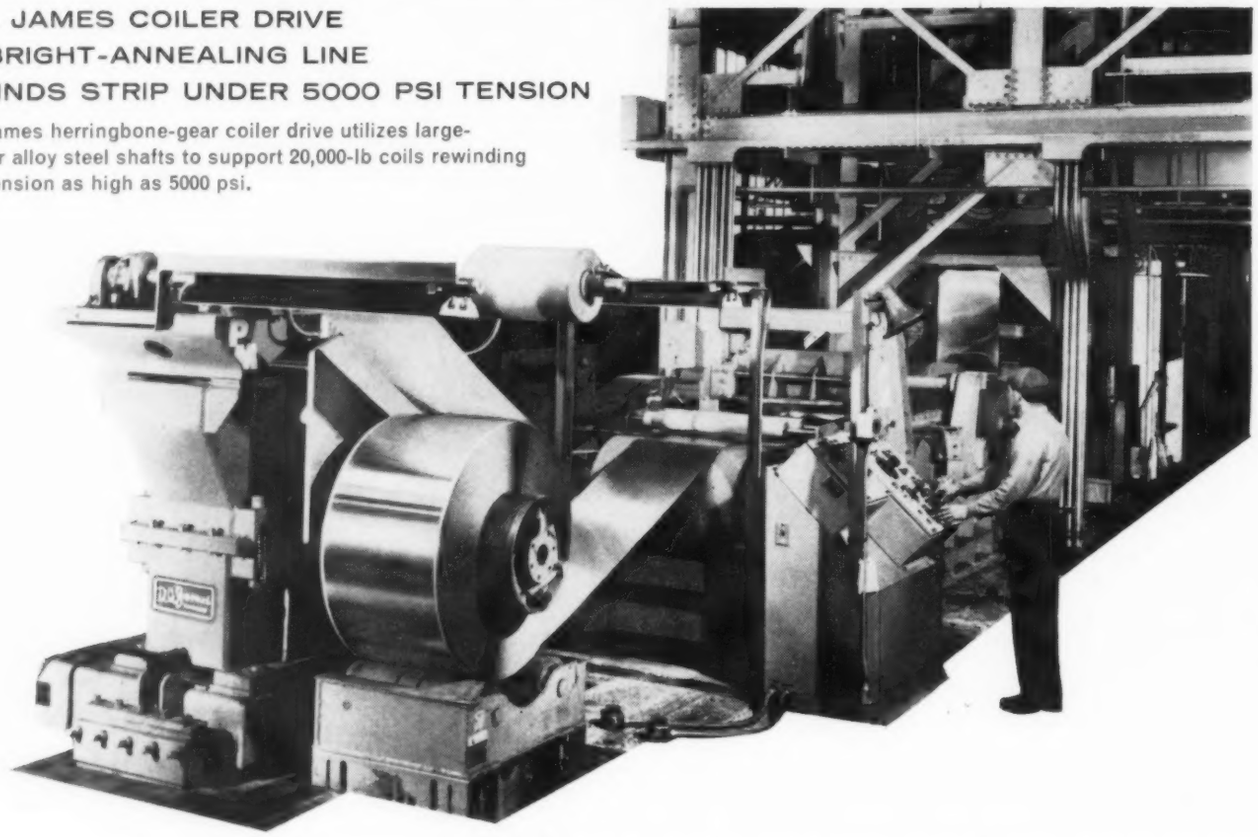
▲ With TSP axles, maintenance costs from axle breakage, have been greatly reduced.



▲ TSP liners on blooming mills last for years without replacement.

D. O. JAMES COILER DRIVE ON BRIGHT-ANNEALING LINE REWINDS STRIP UNDER 5000 PSI TENSION

D. O. James herringbone-gear coiler drive utilizes large-diameter alloy steel shafts to support 20,000-lb coils rewinding under tension as high as 5000 psi.



What are your coiler, tension reel drive requirements?

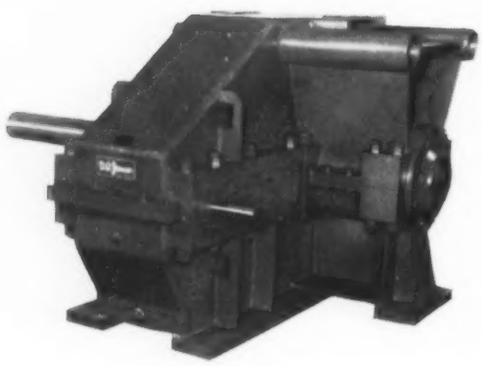
D. O. James specializes in coiler and tension reel speed reducers for all types of continuous strip-processing lines: slitting, grinding, side trimming, pickling, leveling, plating, cleaning.

Rigid, fabricated steel housings accommodate coil pusher rods; support tubes for coil separating, tensioning, or sensing mechanisms; and mounting pads for pusher cylinders or other special equipment.

Wide antifriction bearings mounted in extra-heavy plate maintain coil block concentricity for smooth, even recoiling.

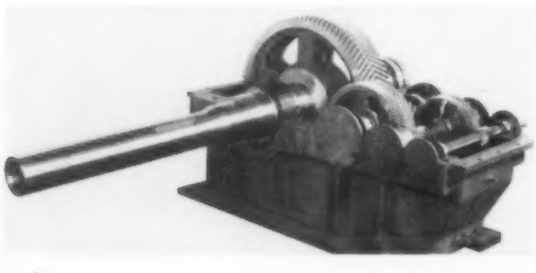
Standard units available with double-reduction ratios from 10:1 to 75:1; triple-reduction ratios from 85:1 to 370:1, in a wide horsepower range. Two-speed ratio combinations optional for wider range of speed variation.

For complete facts, contact your D. O. James representative or write for Catalog 16-60.



Rigid, fabricated steel housings are designed for your own coiler and reel drive requirements.

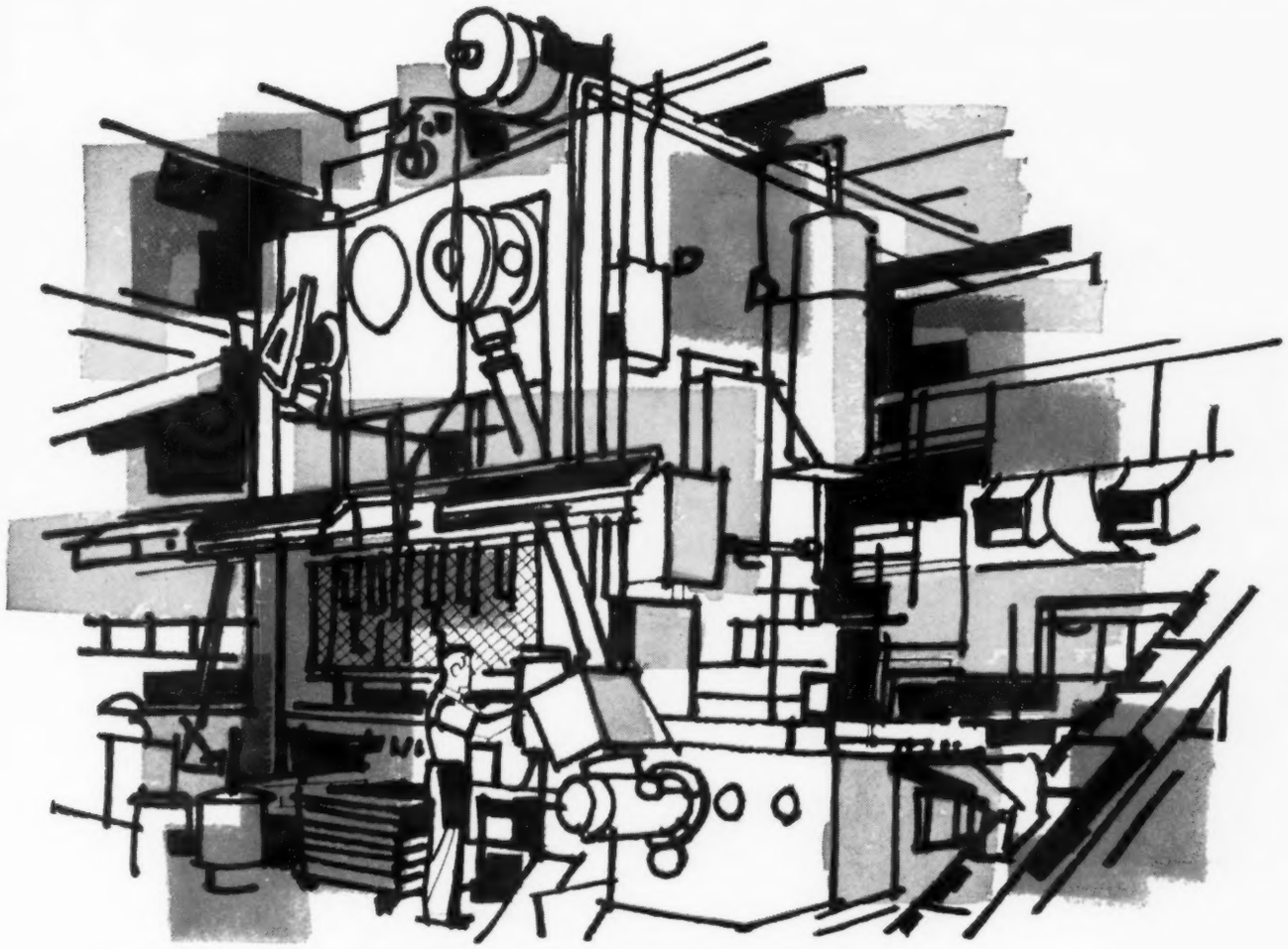
Extra-wide bearing span in triple-reduction unit supports wide strip or exceptionally heavy coils.



D. O. JAMES GEAR MANUFACTURING CO. 361
1140 West Monroe Street, Chicago 7, Illinois
Since 1888, every type of gear and gear speed reducer

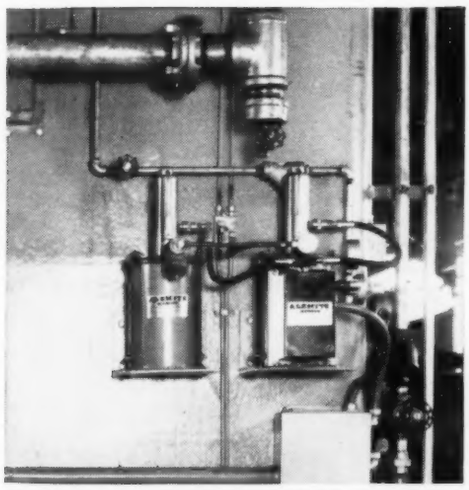
D.O.James

...where you always get good gearing



ALEMITE ACCUMATIC SYSTEM LUBRICATES 300-TON PUNCH PRESS

Automatically...in seconds!



An Alemite Accumatic Centralized Lubrication System lubricates the key points on this 300-ton, 20-foot high Punch Press which can produce 1200 completed stampings per hour at 25 strokes per minute, based on 80% efficiency.

Complete with pump, metering valves, supply lines and controls, this Accumatic system offers all these advantages: It automatically meters out the exact amount of lubricant needed at each bearing on a predetermined cycle . . . never over- or under-lubricates. Guarantees lubrication of those out-of-the-way bearings frequently overlooked; protects against bearing wear due to neglect. Services *all* bearings in a single operation . . . in seconds . . . while the machine is running eliminating work stoppage . . . adding production hours to each day.

This installation is typical of the versatility and wide range of Accumatic's precision lubrication . . . typical of how Alemite's experience and products work together to provide the right lubrication system for machines of all types and sizes. Today, find out how Alemite and Accumatic can do a *big job for you,* too! *Send for free illustrated literature . . . or contact your Alemite representative.*

Symbol of SW Excellence

ALEMITE DIVISION
STEWART-WARNER CORPORATION

In Canada: Stewart-Warner Corporation of Canada Ltd., Belleville, Ontario

Dept. F-111, 1850 Diversey Parkway, Chicago 14, Illinois

This is what our customers say:

GLASGOW MAN STABBED

John Ross, a biscuit factory worker, was stabbed during a scuffle at a public-house in Abercrombie Street, Glasgow, yesterday. Police prevented customers from leaving, and the injured man, who lives at 22 Hopehill Road, Maryhill, was rushed to the Royal Infirmary. His condition is serious.

THIS MILL MEANS BUSINESS

DEMAG

DEMAG

work on Lanarkshire's Universal Beam Mill at otland's steel town, is now almost complete. re now in progress and very soon Universal olumns bearing the familiar brand 'The el Co. Ltd.' will be freely available. This new of many modernisation projects being under- of Companies to ensure that the

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MOTHERWELL SCOTLAND · ONE OF THE COLVILLE GROUP OF COMPANIES

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DEMAG

planned and built 6 complete wide-flange beam mills for customers at home and abroad

Representatives in USA:
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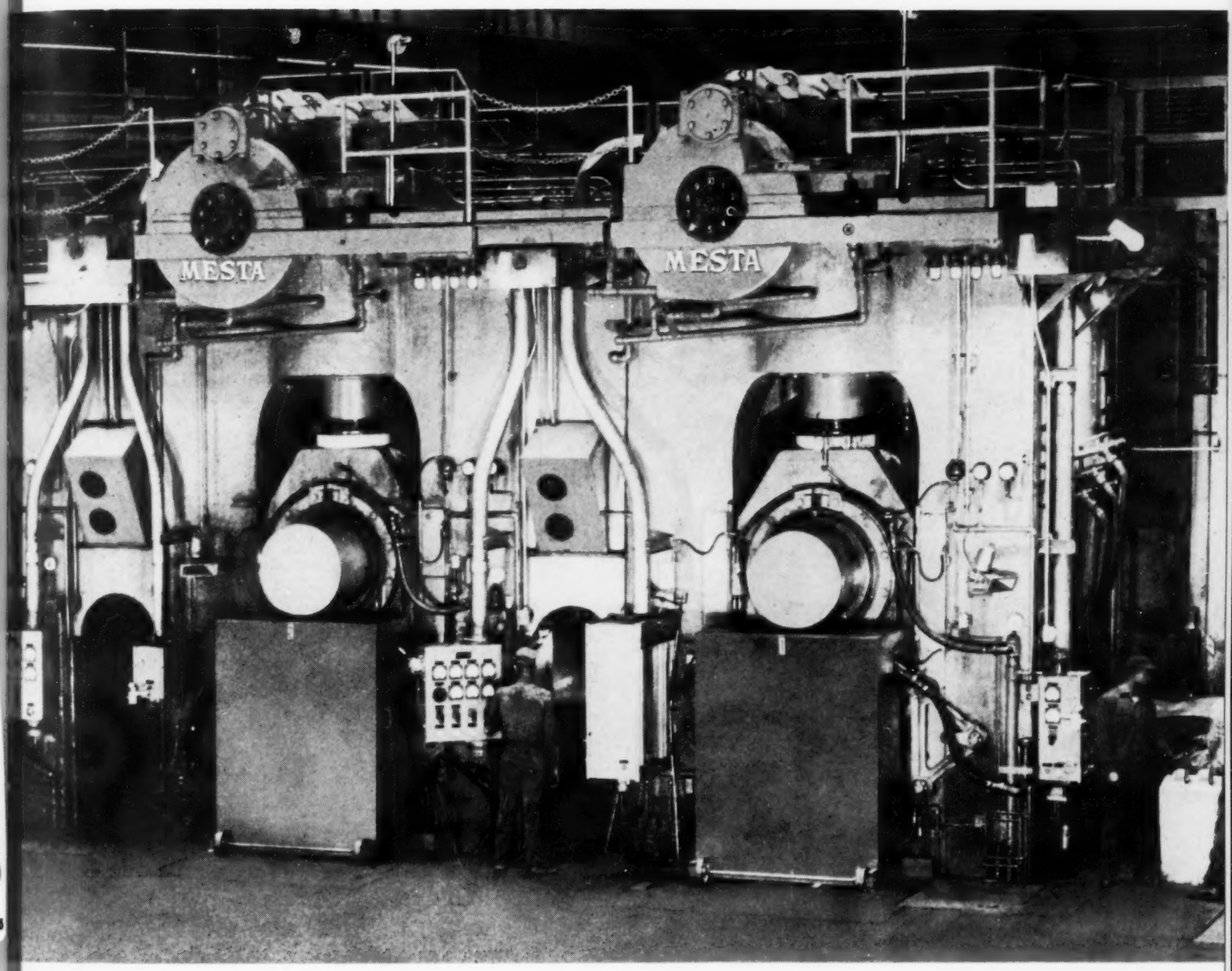


Speed: 7,250 feet per minute
Size: 6-stand 52″ tandem cold mill
Power: 34,900 main drive hp
Thickness Range: .035 to .0035

Early this year, The Youngstown Sheet & Tube Company began rolling tin plate from a new mill at Indiana Harbor. The mill is the largest and fastest such facility installed to date, and also the most completely automated installation of its kind.

All six stands are governed by Magamp magnetic amplifiers, which accurately regulate the response of motors and power supply generators. Automatic gauge control with completely static circuitry assures uniform strip through each stand, and maximum on-gauge finished strip at maximum rolling speed. Every factor in the rolling process is supervised by instruments and controls at the master console. Data logging equipment provides a complete record of gauge, width and inspection information for each coil as it passes through the mill. Data is accumulated as the coil is run, and automatically typed for order processing and record keeping. A total of 18 items of information are recorded plus inspection faults detected.

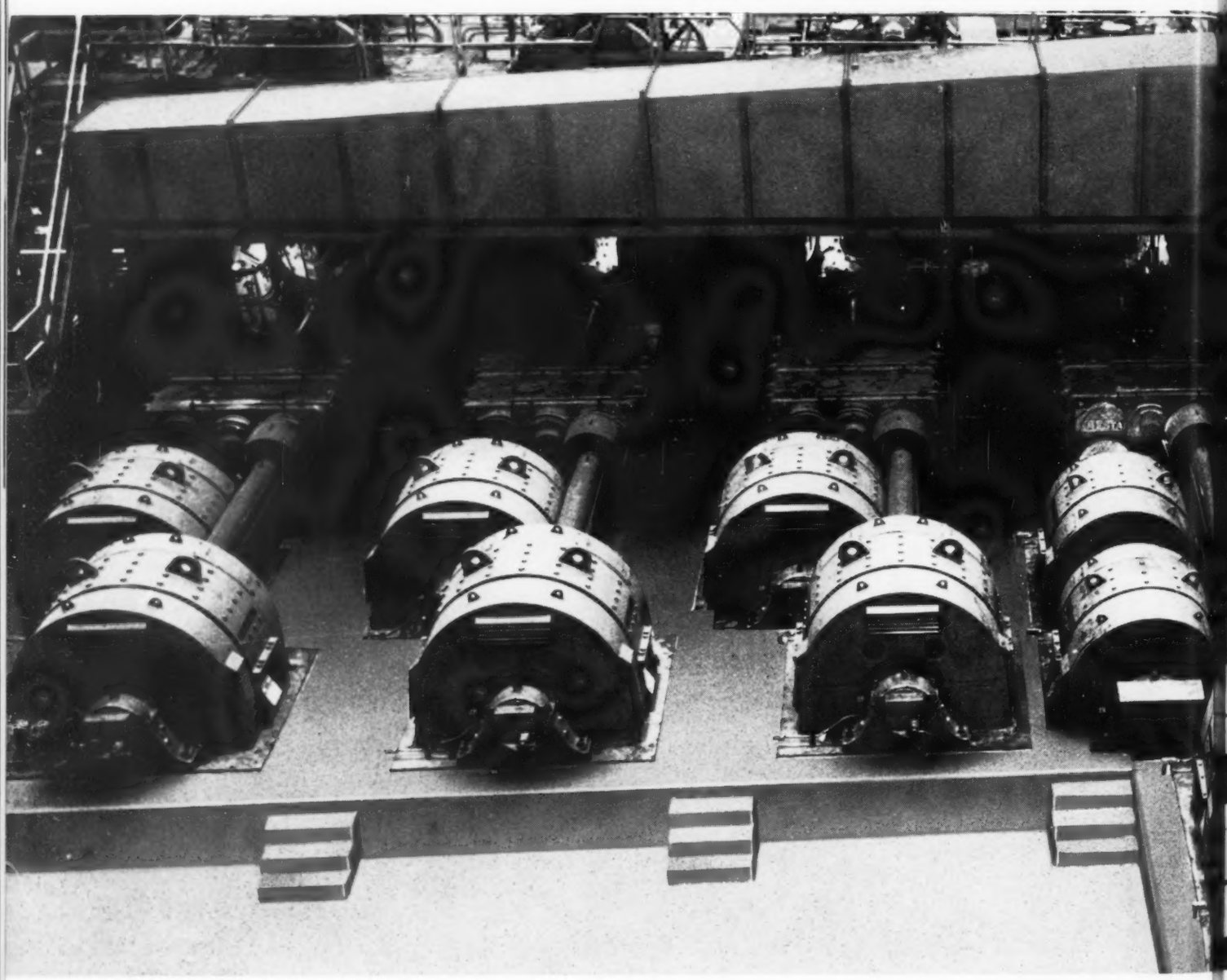
Virtually all control circuitry is entirely static. Magamp regulation requires no interposing exciters or complex damping circuits. This basic simplicity assures extremely high accuracy and reliable performance throughout the rolling cycle.

From the planning stage to start-up of the new mill, a *(continued on next page)*

First 6-Stand Tin Plate Mill

One of the three main power supply Westinghouse Motor-Generator sets located in the mill area. This MG set has a total of 8800 kw, is driven by a 12,000 hp synchronous motor.

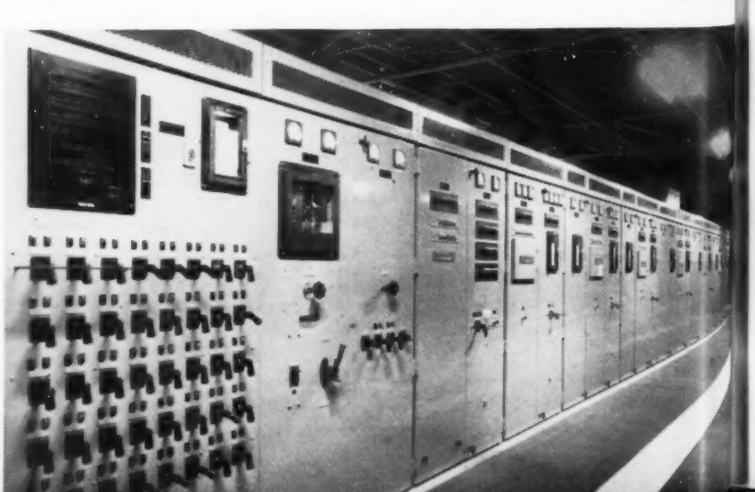
Below—Drive view of Youngstown Sheet and Tube's new 6-stand tandem cold mill. Westinghouse main mill drives range from 3000 hp (Stand #1) to 7500 hp (Stand #6). Twin, twin double armature and twin triple armature drives plus reel drive total 34,900 hp.



Westinghouse project coordinator followed every aspect of the job, working with the machinery builder and mill personnel. Weeks before start-up, Westinghouse specialists began training Youngstown crews in operating the complete mill and its control systems. The reward for these efforts was a remarkably trouble-free start-up.

The Westinghouse team of specialists in power and controls accepts one-source responsibility right from the start. Contact your Westinghouse sales engineer for details, or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

You can be sure . . . if it's Westinghouse.



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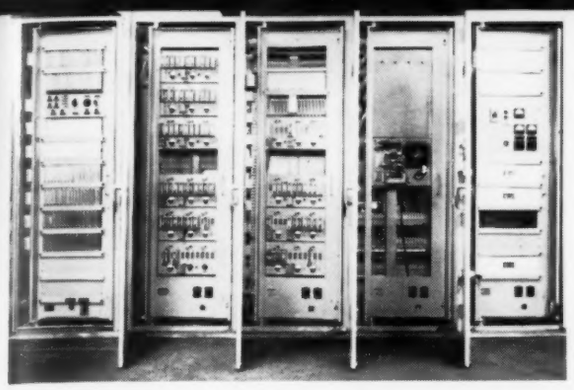
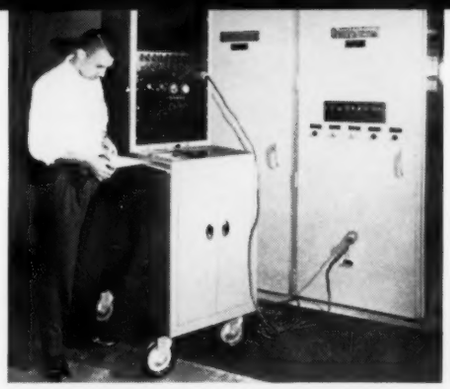


Westinghouse's PRODAC* all-static system handles automatic gauge control and total data logging functions for the high-speed mill. Readout covers 18 points of information plus recording any inspection faults detected.

*Trademark



Westinghouse PRODAC design incorporates mobile test console pictured. Unit permits convenient changes in mill set-up, or quick circuit checks through front mounted plug-in shown.

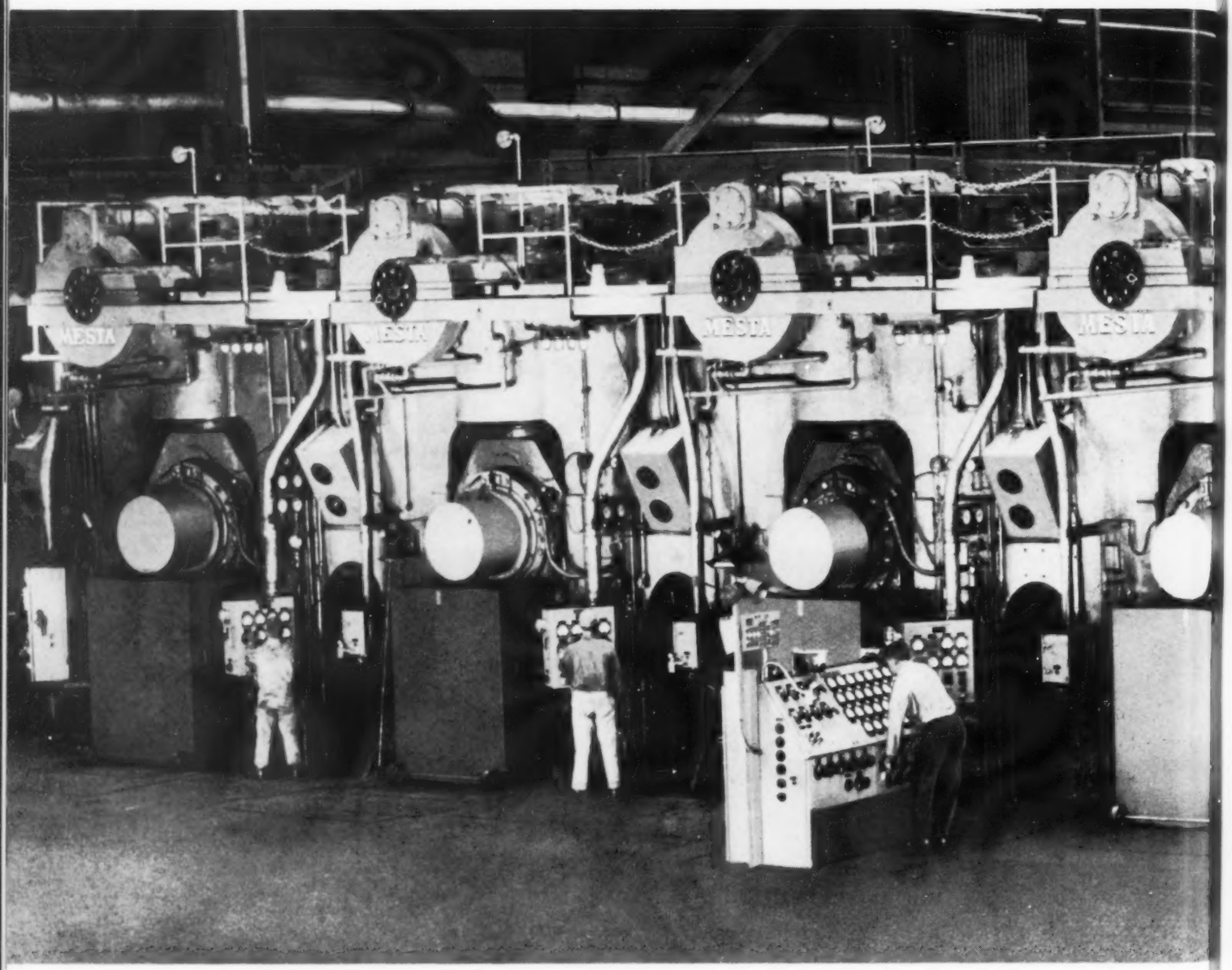
Interior view of control house on mill floor. Cabinets shown house Westinghouse Main Drive Controls.

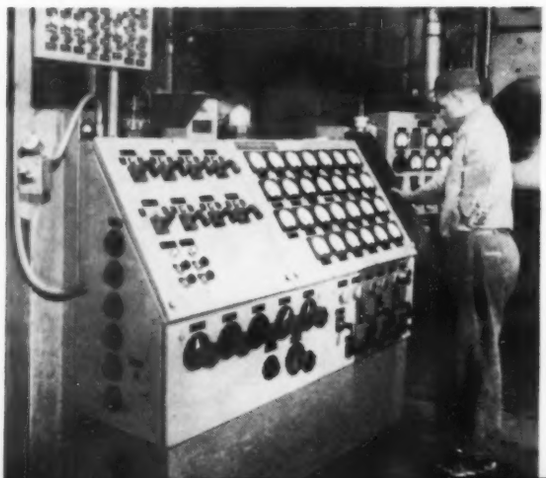
View of Westinghouse equipment located below mill floor. The only auxiliary rotating equipment required for main drive is 400 cycle alternator, constant potential exciter and voltage reference exciter shown in the center of photo.

Westinghouse

J-06191-C

World's First 6-Stand Tin Plate Mill . . . Powered and Automated by Westinghouse





Above—Front view of 6-stand mill showing individual stand controls and Master Roller's desk.

At Left—Close-up of Master Roller's Desk. All supervisory mill controls are centralized here.

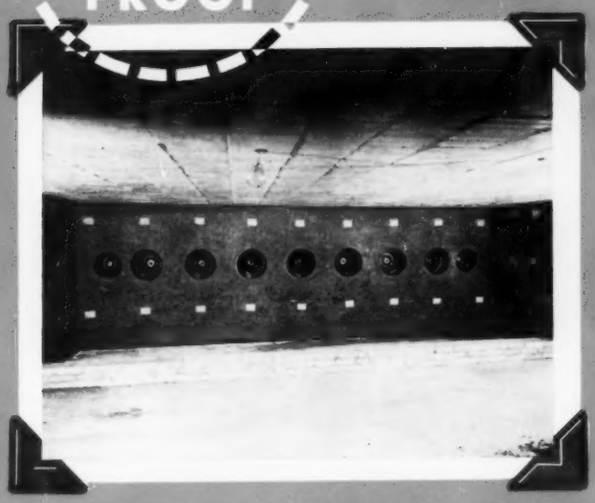
J-96191-1

HERE'S UNRETOUCHED PROOF

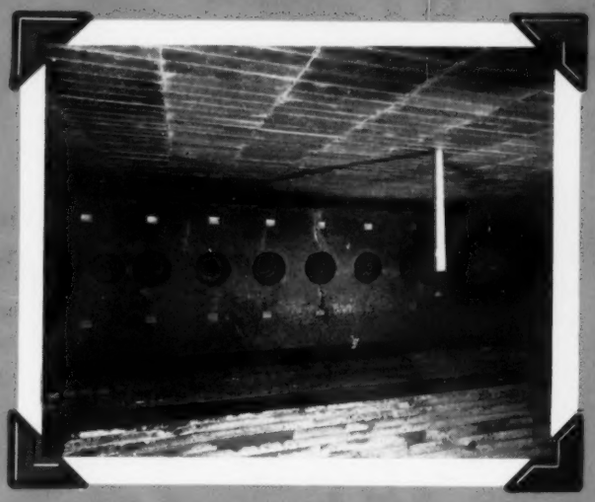
. . . in rail and billet reheating furnace at

INLAND STEEL

Plibrico plastic refractory lining shows how it can take punishment



APRIL 1960 . . . view shows front burner wall of rugged, shock-resistant Plibrico Super "F".



TODAY . . . unretouched photograph of same area shows how Plibrico Super "F" withstands punishment in this high heat zone.

APRIL 1960 . . . view at charging end shows sidewall and flared doors also formed with Super "F", a grade for high heat conditions.

TODAY . . . unretouched photograph illustrates Plibrico's tight, stable monolithic lining of Super "F" after almost one year in service.

PLIBRICO OFFERS A WIDE SELECTION of plastics, castables, gunning and ramming mixes formulated to give you exactly the properties and characteristics you need. Get complete data on Plibrico products and their advantages from your local Plibrico man.

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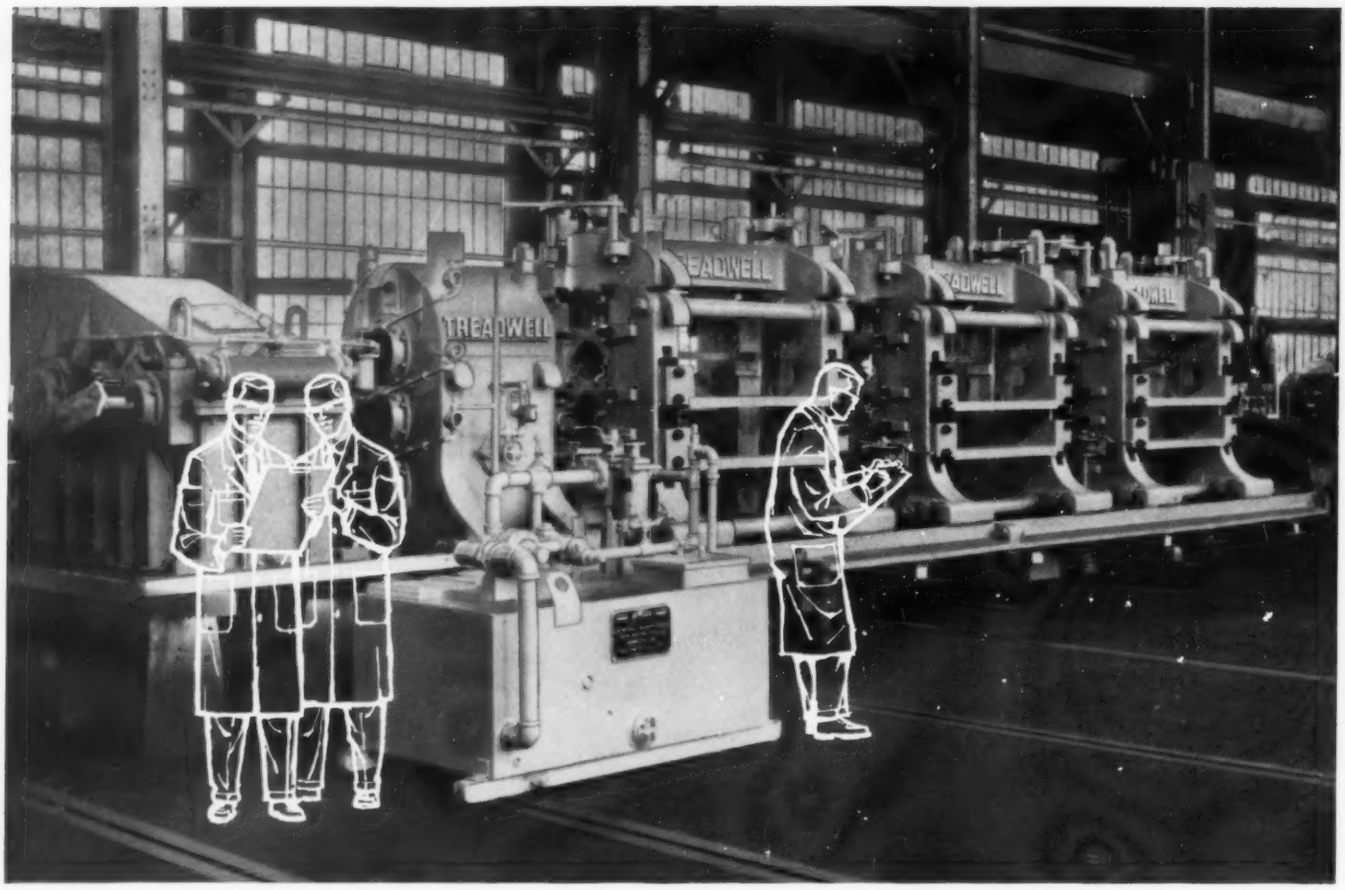
CATALOGS 68 & 71 cover plastics, ramming mixes and castables giving advantages and applications.



DRESS REHEARSAL

of a TREADWELL PRODUCTION

This 14″ 3-Hi Bar Mill, pinion stand and drive is ready for final inspection of the coordinated work of design, engineering and shop staffs.

Every piece, every part must pass muster on a check list that guarantees top performance before shipment to the customer. It has been said that Treadwell's final inspection routine is too severe and detailed. But we know that our customers are confident, through past experience, that the equipment will perform with Treadwell excellence, without expensive, unexpected alterations. That is the best *satisfied customer insurance* there is.

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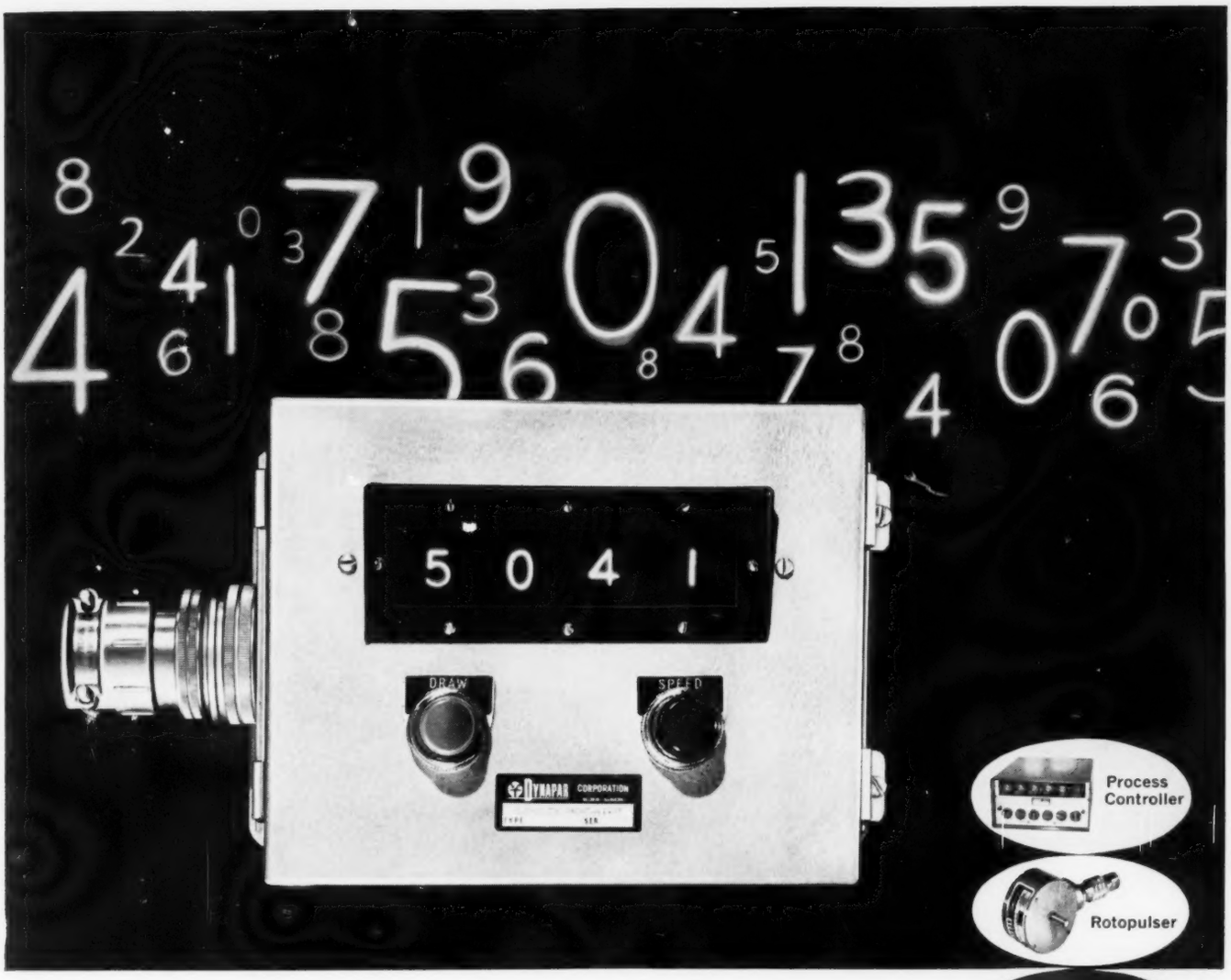

NOW...Louis Allis offers DYNAPAR* Digital Control Systems!

Louis Allis can supply accurate digital controls designed to industrial standards for a wide variety of continuous process lines

For any production process, Louis Allis can furnish not only motors, drives, and controls, but also digital monitoring equipment to provide visual readout and process control signals.

The answer is DYNAPAR Digital Control — a highly accurate digital logic system that can count, measure, totalize, indicate, time, or control depending on the requirements of the application. Digital systems are ideally suited for high speed counting — accurate measurement of speed and draw — automatic cutting-to-length — automatic positioning — and many other applications.

Dynapar's digital devices utilize precise pulses, and eliminate the drift inaccuracy inherent in magnitude-measuring analog systems. There's no need for constant calibration or adjustment. Pulses are reliably provided by rugged ROTOPULSERS, highly stable sensing and pulse generating devices—visual indication is obtained by easily-read luminous direct numerical readouts. Control functions are accomplished by a variety of special devices tailored to specific operations. All DYNAPAR equipment features the most modern solid-state transistorized circuitry to provide long-life operation without maintenance.

Investigate to see how Louis Allis-Dynapar equipment can increase production and cut waste by automating *your* process. Call your local Louis Allis District Office, or write to The Louis Allis Co., 450 E. Stewart Street, Milwaukee 1, Wisconsin.

*Dynapar Corporation is the electronic subsidiary of The Louis Allis Co.

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MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

D-226

ENGINEERED AIR (by AAF) keeps it clean!

● This intricate control panel at Jones & Laughlin Steel Corporation's Cleveland Works typifies the importance J&L places on the operation of its electrical equipment. Typical, too, was their insistence on the *right* kind of protection against dust damage.

J&L installed *five different types* of AAF filters to meet the differing clean-air needs of equipment serving its open hearth shop, blooming mill, finishing division and sintering plant. Result: at each filter installation, J&L has the *air cleaning efficiency it needs* plus *the maintenance characteristics it wants.*

To make sure you get clean air that's engineered for *your* specific needs, talk with the *one* company that makes *all kinds* of air filters—AAF. For more information, call your local AAF representative or write us direct. Address: Mr. Robert Moore, American Air Filter Company, Inc., 302 Central Avenue, Louisville, Ky.

AAF American Air Filter
BETTER AIR IS OUR BUSINESS

GIANT LADLES
as large as ??? tons

(Above, left) World's largest iron charging ladles; 230-tons capacity, with new type scalene-cone nose for very rapid pouring into oxygen furnaces.

(Above) 350-ton capacity ladles, ready for shipment.

(Left) Center segment of 400-ton capacity ladle, leaving the PECor plant.

400 TONS—WE'RE NOW BUILDING TWENTY-EIGHT FOR A SINGLE STEEL PRODUCER. **400 TONS**—WE'VE BUILT FOURTEEN. **500 TONS**—WE COULD BEGIN PRODUCTION TOMORROW!

Whatever your ladle requirement, PECor will add important plus features in design . . . and will deliver assured reliability—ladles notable for staying on-the-line and making steel.

May we discuss any phase of ladle design, fabrication or repair?

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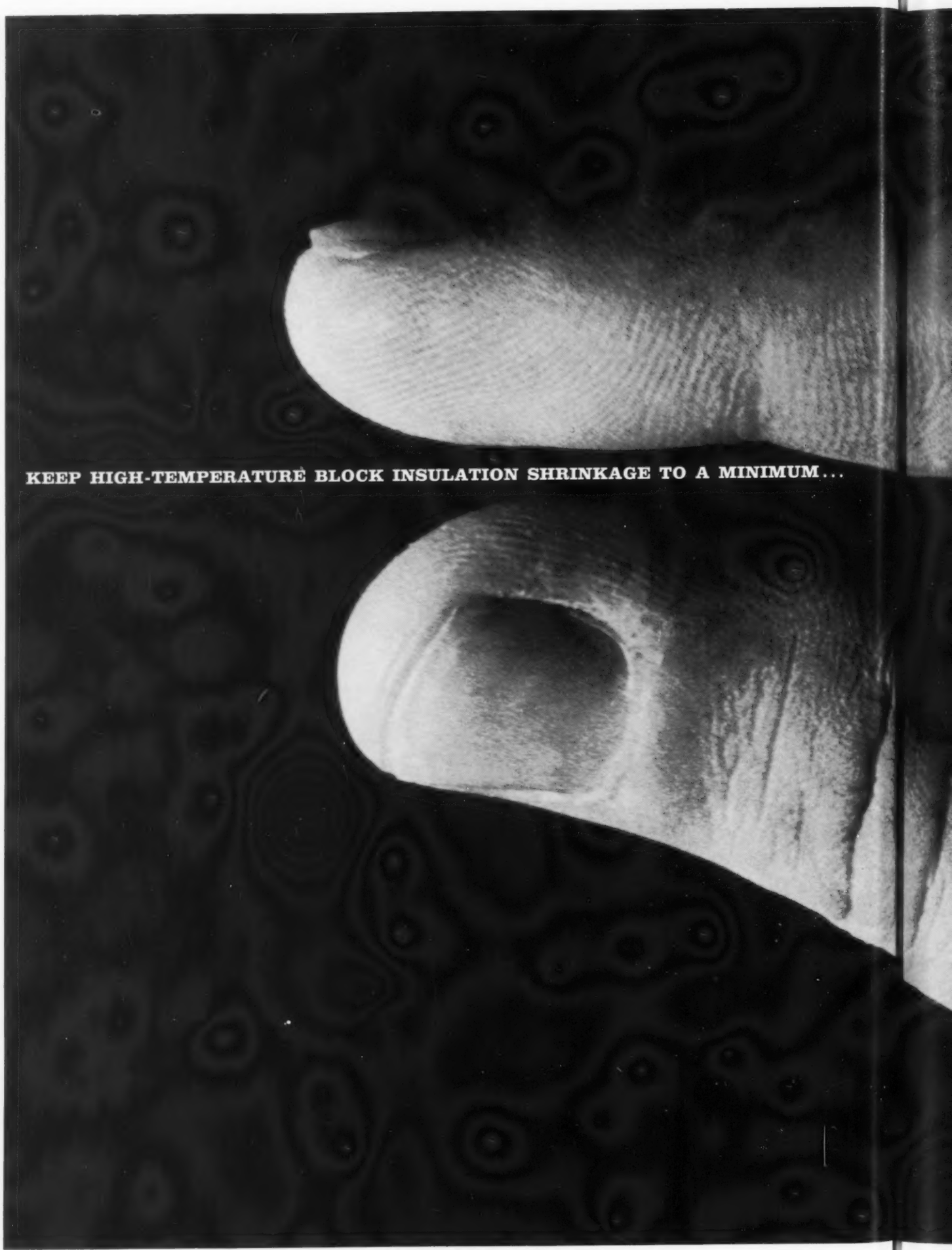

KEEP HIGH-TEMPERATURE BLOCK INSULATION SHRINKAGE TO A MINIMUM...

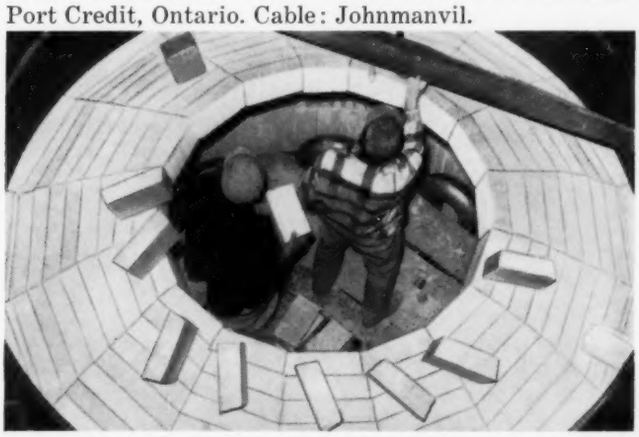
And, get high strength, light weight and low conductivity –all with J-M Superex Blocks

For the lowest shrinkage and maximum strength at extremely high temperatures, heating engineers throughout the country choose Johns-Manville Superex® blocks.

Made of diatomaceous silica and asbestos, Superex can withstand temperatures up to 1900F. Even when subjected to this extreme heat, Superex's linear shrinkage is only 2.7%. What's more, its low conductivity at high temperatures (.82 at 1000F mean temperature) and high compressive strength (only ⅛" compression under 85 lbs. per square inch) provide excellent efficiency and long, maintenance-free service.

Superex has built-in installation economies, too! Its light weight, large 12" x 36" size and dimensional uniformity make for fast, sure installation. No wonder J-M Superex is the preferred insulation for hot blast stoves.

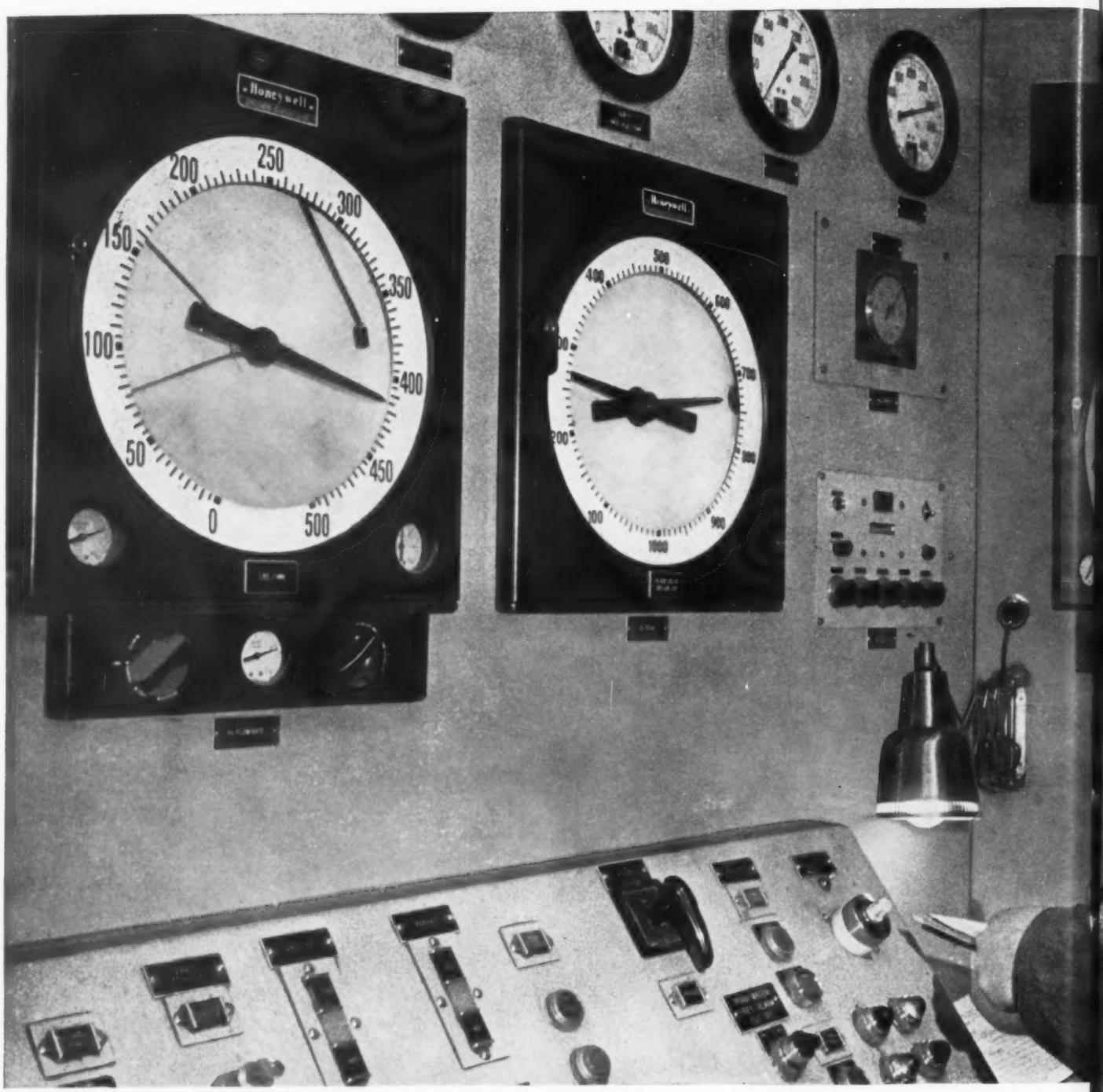
For full details, write to J. B. Jobe, Vice President, Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario. Cable: Johnmanvil.



The light weight and large size of J-M Superex provide fast, simple installation.

JOHNS-MANVILLE

AN INSULATION FOR EVERY COMMERCIAL AND INDUSTRIAL USE



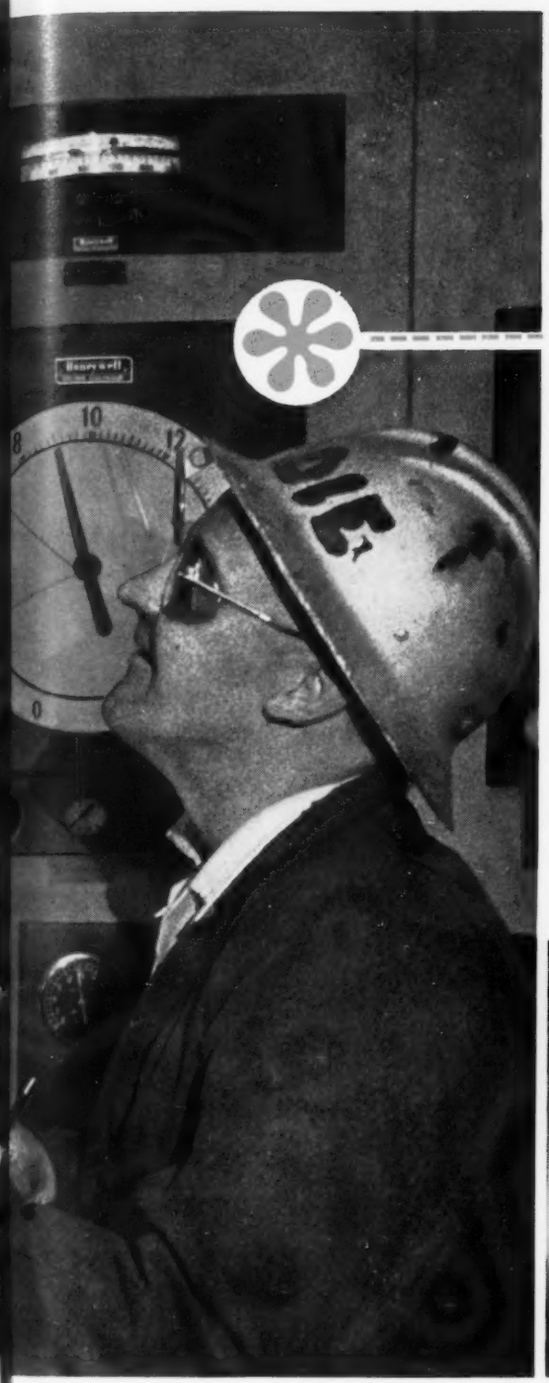
In a cubicle near the converter, an operator closely follows the progress of a blow. These Honeywell instruments indicate, record and control such variables as oxygen mass flow, lance cooling water temperature and pressure, lance position, and hood temperatures.

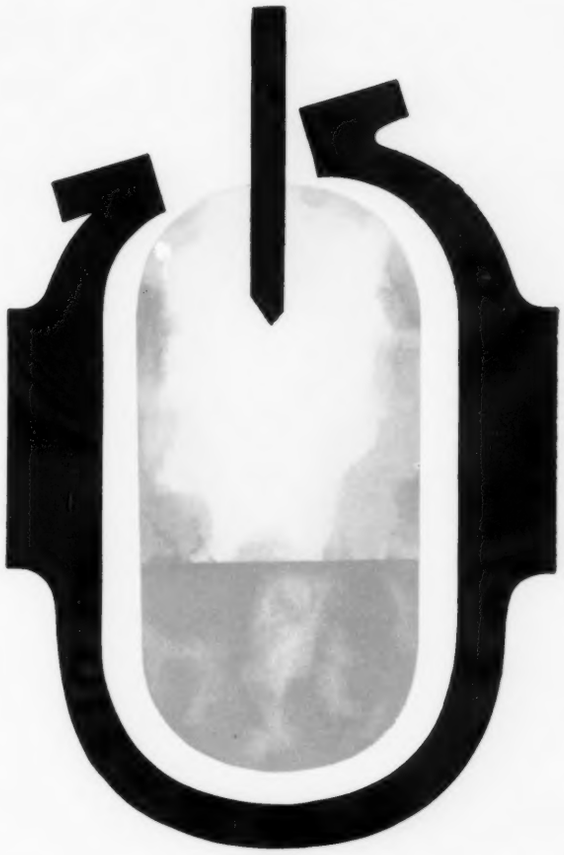
Honeywell-controlled BOF process

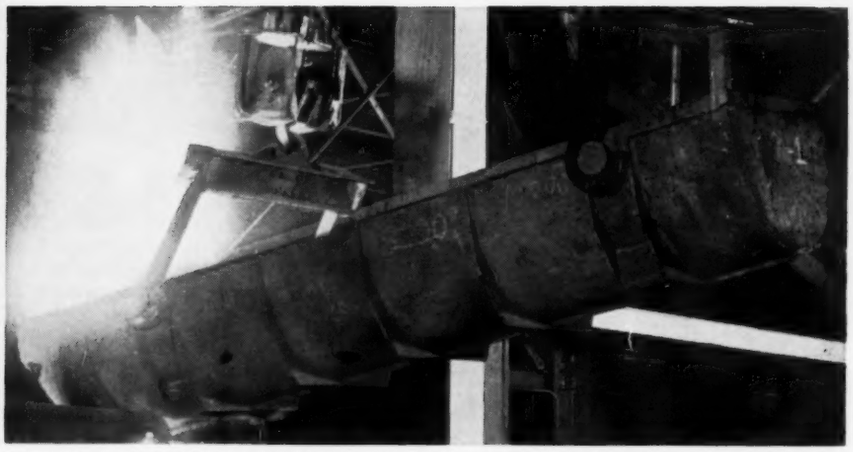
Acme Steel used to buy semi-finished steel slabs and billets to produce rolled strip, floor plate, strapping and other finished steel products. When limited supply threatened to block the company's potential growth, it turned to the basic oxygen furnace process as the economical method of producing its own steel.

Now, Acme's Chicago mill can produce a 75-ton heat of steel every 40 minutes with its new Honeywell-controlled oxygen process. Two continuous-flow hot blast cupolas are teamed with two oxygen converters to make many types of steel in small batches, at low cost per ingot ton.

The flexibility and economy of the mill's oxygen process stem largely from a carefully-engineered control system. Honeywell instrumentation accurately meters high-purity oxygen, maintains efficiency of the converter blow, protects equipment from excessive temperatures and guards safety of operating personnel.







Using a basic charge of about 80 percent molten iron and 20 percent scrap, Acme Steel's oxygen converters produce high-grade steel at low cost. About 2,000 cubic feet of high-purity oxygen is required for each ton of steel.

makes Acme Steel its own supplier

If you're planning to use oxygen—in a BOF or open hearth—you'll find it profitable to have Honeywell design your entire control system, tailored to the particular requirements of your mill. Your nearby Honeywell field engineer can give you full details. Call him today—he's as near as your phone.

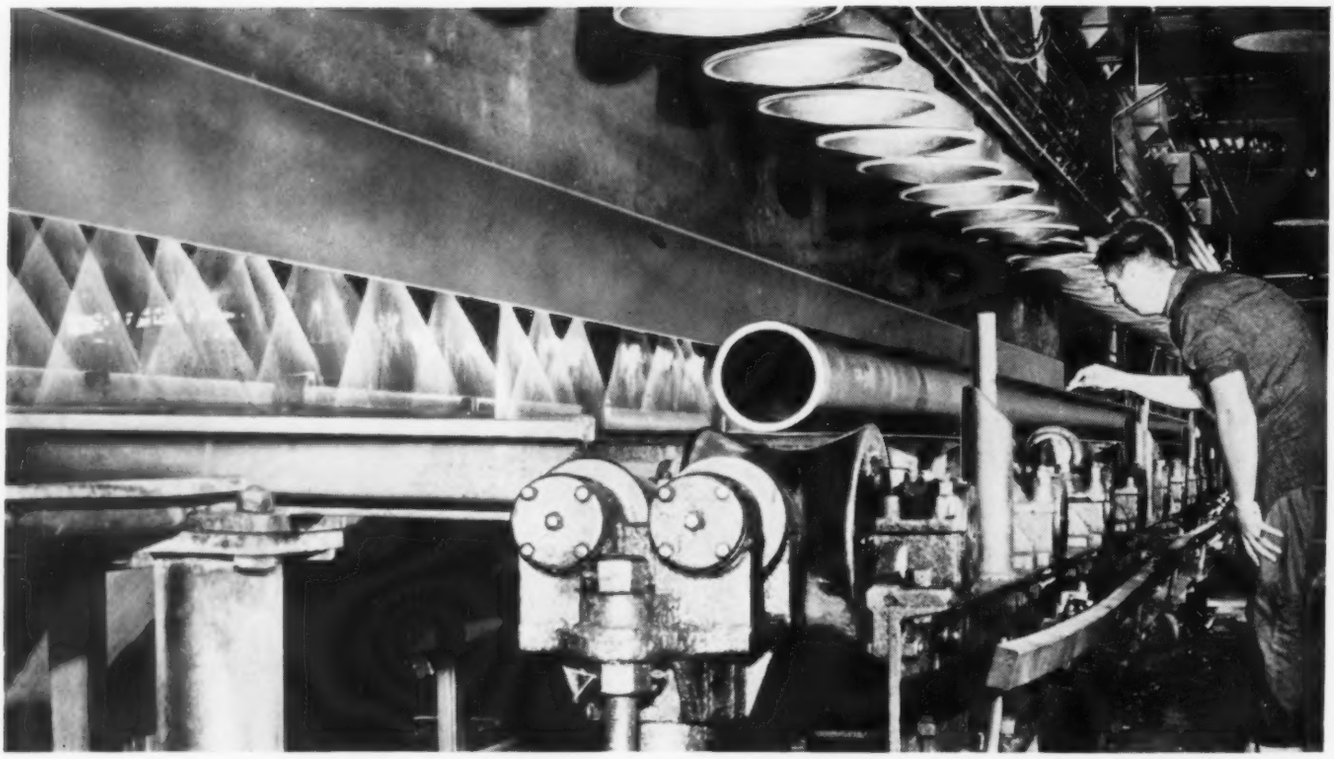
MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.



Automatic high speed Magnaglo Test System detects surface cracks in large tubing and pipe. Tube is supported over a roll conveyor by jacks which turn it for inspection on all sides. Cracks are marked with crayon for subsequent removal by grinding. Spray nozzles (left) bathe tube with Magnaglo fluorescent particle suspension before tube rolls into the inspection booth. Black light is supplied by a bank of 34 high intensity lamps.

automatic high speed testing

finds critical cracks in 48′ steel pipe

This pipe is critical. It goes into oil wells where, thousands of feet below the surface, a failure is not only expensive, but can cause the loss of much production from an entire oil field. So, even the smallest cracks must be found—and inspection must be fast.

Magnaflux devised the test system that includes fully automatic handling and testing of seamless tube up to 48′ long and 10¾″ in diameter. The big pipe is conveyed and passes in continuous flow through the Magnaflux-Magnaglo inspection unit. Magnetized under 6000 amperes, full wave DC, it passes under a double row of spray nozzles that bathe the pipe with specially developed fluorescent Magnaglo particles. Moving on, it is raised by jacks and rotated to permit inspection under black lights. Even the smallest crack is impossible to miss with Magnaglo. Only a single inspector is required.

Pipe with defects is tipped off the conveyor for corrective surface grinding on an adjacent grinding table, and retesting. No pipe with significant defects ever gets to a customer!

This high-speed automatic unit is just one example of Magnaflux' ability to supply test systems to meet virtually any testing need. These can be automatic, conveyorized inspection or individual parts inspection, for ferrous or nonferrous materials.

There is—or can be developed—a Magnaflux Test System to meet your test needs exactly, for a few parts or a few million—from billets to bolts. The Magnaflux Field Engineer, backed by the total experience of Magnaflux—"The House of Answers in Nondestructive Testing"—is ready now—to help you get *more* profitable production to *any* quality level *your* use determines.

Ask for a meeting soon. Write us—Magnaflux Corporation, 7332 W. Lawrence Ave., Chicago 31, Illinois.

MAGNAFLUX CORPORATION
A subsidiary of General Mills

7332 W. Lawrence Avenue • Chicago 31, Illinois
New York 36 • Pittsburgh 36 • Cleveland 15
Detroit 11 • Dallas 35 • Los Angeles 22

The Hallmark of *Quality* in nondestructive test systems

Magnaflux Test Systems

MAGNAFLUX-MAGNAGLO to test magnetic materials for cracks, seams, etc.
ZYGLO for nonmagnetic and other materials; cracks, leaks, etc.
SONIZON Ultrasonic Thickness Measuring
STRESSCOAT to find and measure stress on parts, overall!
MAGNATEST electronic testing for hardness, conductivity, alloy, proximity, and many more. Also for precision magnetic field measurement.
And still other methods and techniques, some completely new.

Multi-Strand, High-Speed Rod Mill

BLAW-KNOX ROD MILLS

Blaw-Knox designs and builds a full range of multi-strand, high-speed rod mills and merchant bar mills. Other Blaw-Knox equipment for the metals industry includes: Complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals • Sheet and strip processing equipment • Electrolytic tinning, annealing and galvanizing lines • Seamless pipe and tube mills • Draw benches and cold draw equipment • Blaw-Knox Medart cold finishing equipment • Iron, alloy iron and steel rolls • Carbon and alloy steel castings • Fabricated steel plate or cast-weld design weldments • Steel plant equipment • Heat and corrosion resisting alloy castings • Blaw-Knox Company, Foundry and Mill Machinery Division, Blaw-Knox Building, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.

BLAW-KNOX

Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms • Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes • Towers and Special Structures • POWER: Power Plant Specialties and Valves

CHOOSE FROM THE

world's largest industrial annunciator line

AS VERSATILE AS YOUR REQUIREMENT

Lessens downtime by giving *instant visual* AND *audible alarms* when an "off-normal" occurs in your process. Time-saving—pinpoints trouble, permits faster correction and resumption of full production.

- Easily expandable universal system—rugged functional construction.
- Variety of sequences—interchangeable plug-in modules.
- Lowest installation cost—trouble-free operation.
- Over 1,000,000 service-proven hermetically-sealed Panalarm plug-in relays in use.

Universal All-Purpose Annunciator System—can continuously monitor all points in your process. Wide choice of visual and audible sequences (optional flashing, ringback, multi-color visual, momentary lock-in, lamp reset, etc.) permits differentiation between new and previously acknowledged alarms.

Digital Sequential Annunciator. Sequentially identifies your required off-normal points instantly. Handles any number of total alarm points. Clear binary readout. Millisecond resolution between points.

Miniature Solid State Annunciator—economical, lo-drain, intrinsically safe, no moving parts. Engineered for mounting in most standard miniature instrument cases. Compatible with high speed compact computer applications.

Recording Annunciator has both flashing visual and audible alarm simultaneous with exclusive digital alpha-numerical recording of operations. No time-wasting decoding, no useless blank tape accumulation. Automatic, permanent, unalterable statistical record saves operator's time, reduces chance of operator error, permits closer supervision. Equally effective in manned or unmanned locations.

All annunciators available in a considerable variety of standard sizes, cabinets and sequences to economically fit your exact requirement. Write today for descriptive catalog which also details Panalarm's unique quality features.

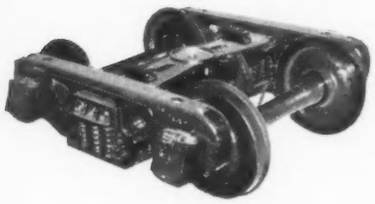
Panalarm manufactures the most complete line of annunciators for information and control. For an optimum competitively priced Annunciator System for your plant, consult Panellit engineers. Sales and engineering offices in all principal cities.

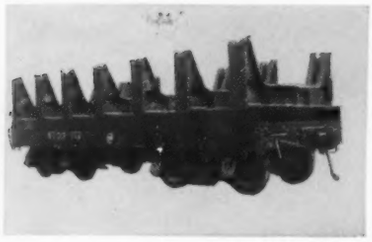
PANELLIT A DIVISION OF **ISI** INCORPORATED

7401 NORTH HAMLIN AVENUE, SKOKIE, ILLINOIS • PHONE ORCHARD 5-2500

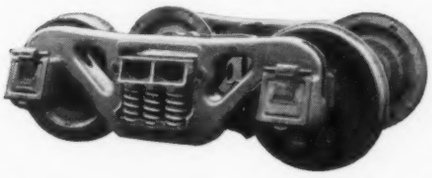
Annunciators • Control Panels • Data Systems • Contract Maintenance and Installation

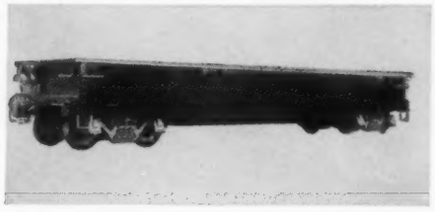
NATIONAL
makes all types of
TRUCKS
for fast, efficient
HAULAGE
in the most modern
STEEL MILLS
in many of the big
INDUSTRIAL
in-plant systems and for America's
RAILROADS



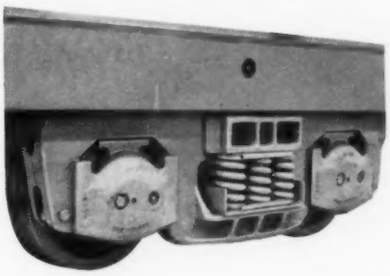


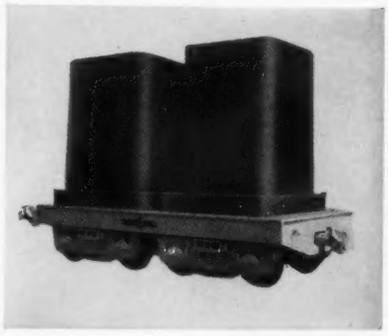
■ *Type "A" Truck*, with 36 load springs per truck, is fully proven in extra heavy duty service on cradle, slab and crop cars. Quick, easy replacement of separable journal boxes in the event of damage, or can use arch bar type journal boxes in emergency.





■ *Type C-1 Truck*, approved by AAR, is volume-produced at low cost. Flexible design accommodates friction bearings (including flat-back type that will not slip during re-railing) or roller bearings. Quick wheel (33″ or 36″) and axle change. No spring planks required.





■ *Industrial Trucks* of many special kinds designed to meet all load requirements and, where possible, interchangeable with present equipment. Feature unique combination of patented rapid wheel and bearing change, lighter bearing loads, balanced stress distribution. A-5373A

Mill Sales • Transportation Products Division

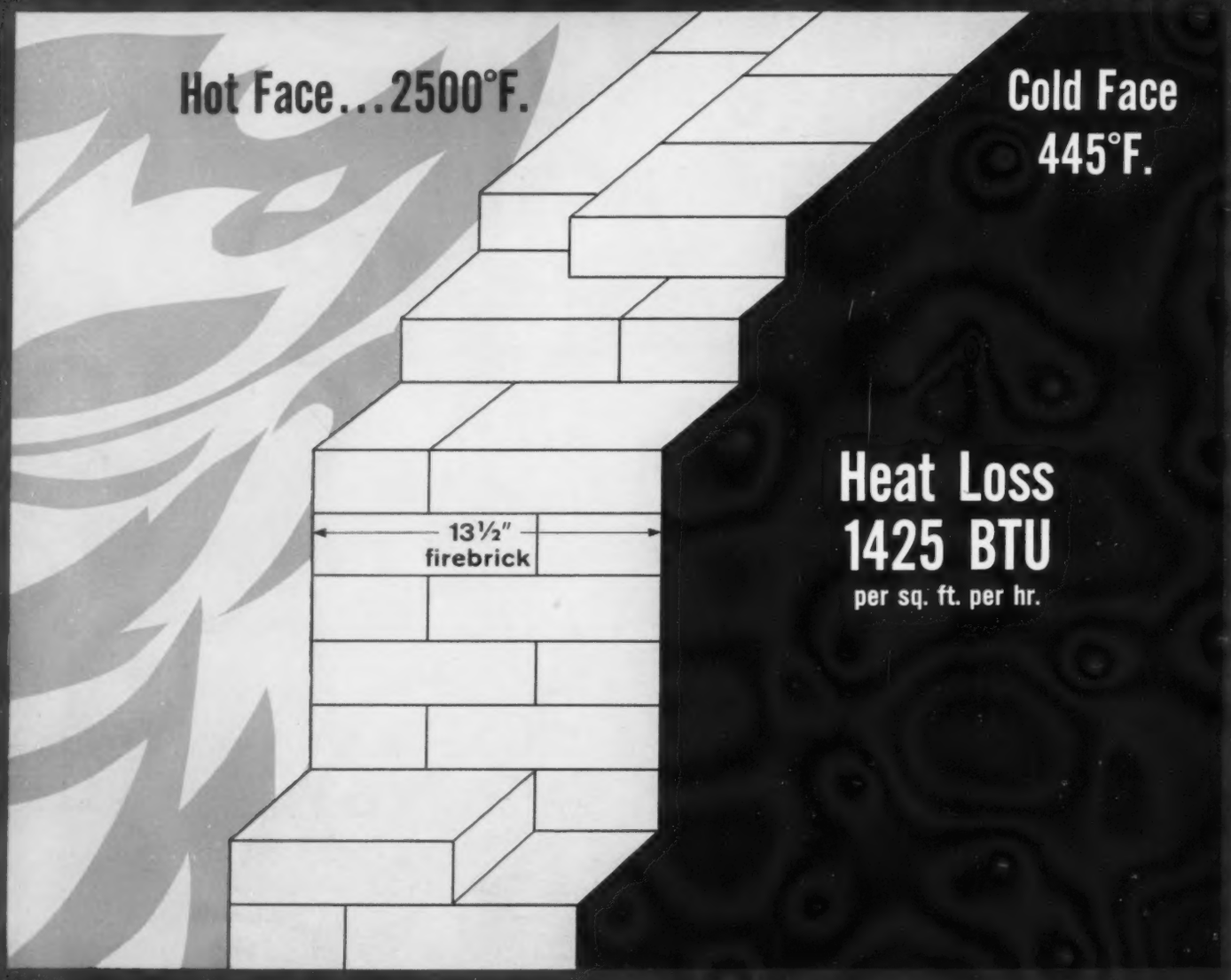
STEEL CASTINGS Centennial 1861 1961 DESIGN WITH STRENGTH IN MIND

International Division, Cleveland 6, Ohio
National Castings Company of Canada, Ltd. 66 Portland Street, Toronto 2B, Ontario

NATIONAL CASTINGS COMPANY
Cleveland 6, Ohio

COUPLERS • YOKES • DRAFT GEARS • FREIGHT TRUCKS • JOURNAL BOXES
ROLLER BEARING ADAPTERS • NATIONAL SPEEDLOADER CONTAINER HANDLING SYSTEM

WHY BE SATISFIED WITH THIS HEAT LOSS . . .



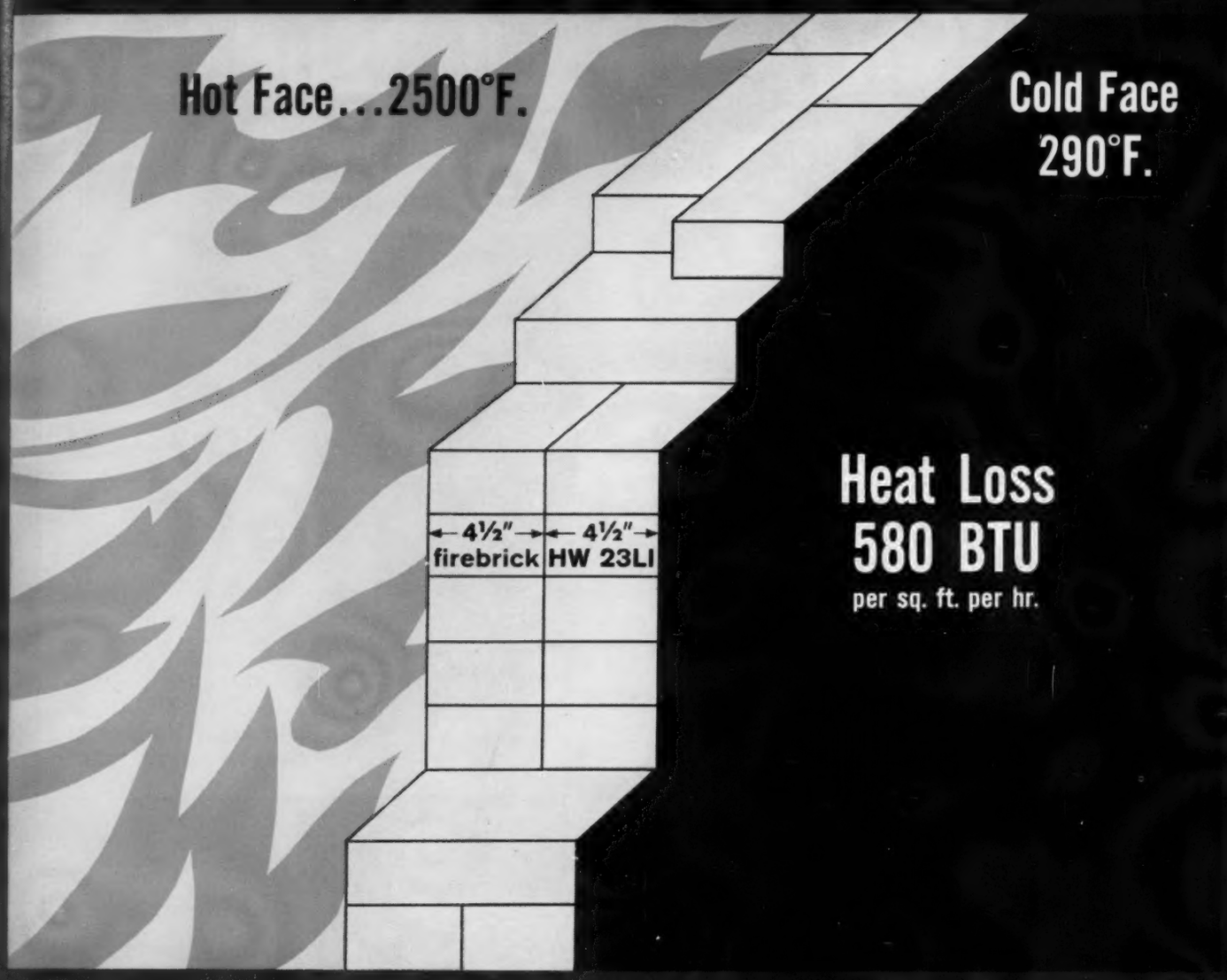
HARBISON-WALKER REFRACTORIES CO.

AND SUBSIDIARIES GENERAL OFFICES PITTSBURGH 22, PA.

World's Most Complete Refractories Service

FOUR REASONS WHY HW 23LI INSULATING FIREBRICK REDUCE HEAT LOSSES AND OVERALL COSTS

WHEN HW 23LI CAN REDUCE THE LOSS 59.3%



1 LIGHT WEIGHT—1.82 LB/9" EQUIV.

This light weight or low bulk density and minute pore size assure low heat storage and high insulating value. The results are substantial savings in furnace weight, construction and fuel.

2 REHEAT SHRINKAGE—0.0% AT 2250°F.

This stability insures longer furnace life, reduces maintenance requirements and lowers overall costs.

3 LOWER THERMAL CONDUCTIVITY—K value at 2000°F.—1.47

The furnace sections above show how HW 23LI—used to back up firebrick furnace walls—have reduced heat losses 59.3%. The savings are substantial in fuel, space, time and weight.

4 ALL THIS—AT NO SACRIFICE OF OTHER IMPORTANT PROPERTIES

The beneficial properties of HW 23LI have been developed without sacrifice of crushing and transverse strength or other desirable physical or chemical characteristics.

HW 23 *Low Iron* Insulating Firebrick were developed especially for controlled atmosphere furnaces. The *low iron* oxide content provides much greater resistance to furnace gas atmospheres than ordinary insulating firebrick. They are also used wherever 2300°F. insulating firebrick are required. Write for complete product and application details.

HW 61-19

FALK INTRODUCES 2 NEW SERIES OF VERSATILE SPEED REDUCERS

Designed to serve industry's current and future requirements

Type YB
Right Angle Horizontal
(write for Bulletin 2100)

Type Y Parallel Shaft
(write for Bulletin 1100)

Parallel Shaft and Right Angle Horizontal Reducers cataloged thru 1,570,000 lb-in. torque at low speed shaft ...larger units upon request. Ratios 1.84 thru 292 to 1 for parallel shaft; 5.06 thru 1207 to 1 for right angle horizontal

These new units are probably the most thoroughly engineered speed reducers on the market today. Final designs based upon years of development study and a background of 50 years experience make these units as dependable as the name "FALK". A few of their many features are...

PINPOINT APPLICATION COVERAGE Wide choice of sizes and ratios permits the most economical selection of a correctly rated unit for each application. In each series of parallel shaft and right angle reducers, cataloged sizes range up to 1,570,000 lb-in. torque at the (11 inch dia.) low speed shaft. (Other standard designs to 25,000,000 lb-in. torque; custom designs for higher capacities.)

UNMATCHED VERSATILITY The "Basic Y" speed reducer design permits economical modification to meet a multitude of specific requirements. Smooth, flat surfaces simplify mounting of motor brackets, backstops, brakes, and any number of other accessories.

RUGGED HOUSINGS Sturdy housings not only provide maximum rigidity to maintain proper alignment of gearing, but also have the strength to support heavy overhung loads and withstand accidental blows.

DEPENDABLE FALK GEARING Gears are selected with the proper proportions and hardness to provide the optimum combination of maximum durability and strength for high shock as well as uniform loads.

BEARINGS TO SUIT THE OVERHUNG LOAD Standard reducers can meet custom-built requirements with optional stock bearings and shafts (at only a nominal extra charge.) Maximum overhung load capacities are so great that for some conditions, still within the capacity of the reducer, extra strong supporting foundations and bolts must be provided.

DOUBLE GEAR LIFE Standard double ended shafts can be reversed end for end to bring into contact the unused surfaces of the gear teeth for twice the normal gear life.

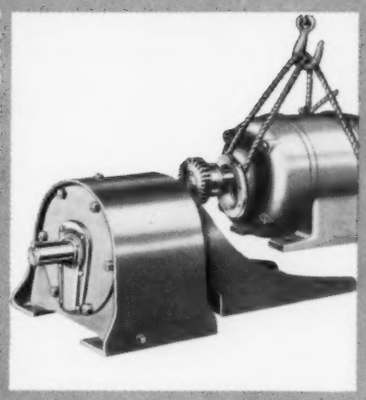
SEALS FOR ALL CONDITIONS Standard equipment oil seals assure oil-tight and dirt-free gear units for normal applications. Standard abrasive and moisture-resistant seals available upon order.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

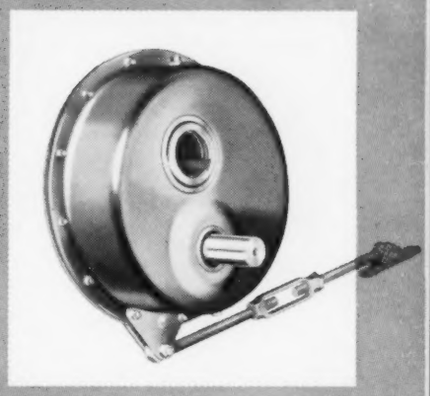
MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in most principal cities

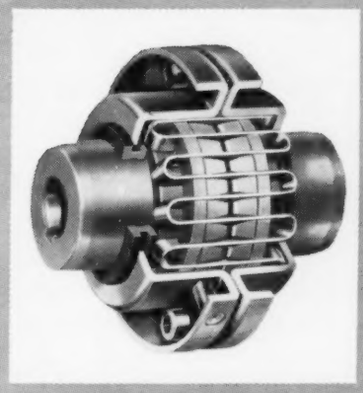
SOME OTHER MEMBERS OF AMERICA'S FIRST FAMILY OF POWER TRANSMISSION PRODUCTS



ALL-MOTOR MOTOREDUCERS



SHAFT MOUNTED DRIVES



STEELFLEX COUPLINGS

FALK

A GOOD NAME IN INDUSTRY

FALK, ALL-MOTOR, and STEELFLEX are registered trademarks

Alloy and Carbon Cast Steel Wheels by

FARRELL-CHEEK

While the need for replacement wheels is ever present in any plant, your purchases will be many times further apart if you make them for wheels and rollers of famous F85 alloy or F-C carbon electric furnace cast steel.

Crane wheels, typical of Farrell-Cheek circular steel castings, have the rigidity, toughness and hardness of treads and flanges to greatly outperform original equipment or replacement wheels.

CATALOG 24 HAS FULL LINE DESCRIPTIONS, ORDERING DATA AND COMPLETE SPECIFICATIONS. WRITE TODAY . . .

"FOUNDRYMEN FOR OVER FIFTY YEARS"

FARRELL-CHEEK STEEL CO.

105 LANE STREET, SANDUSKY, OHIO

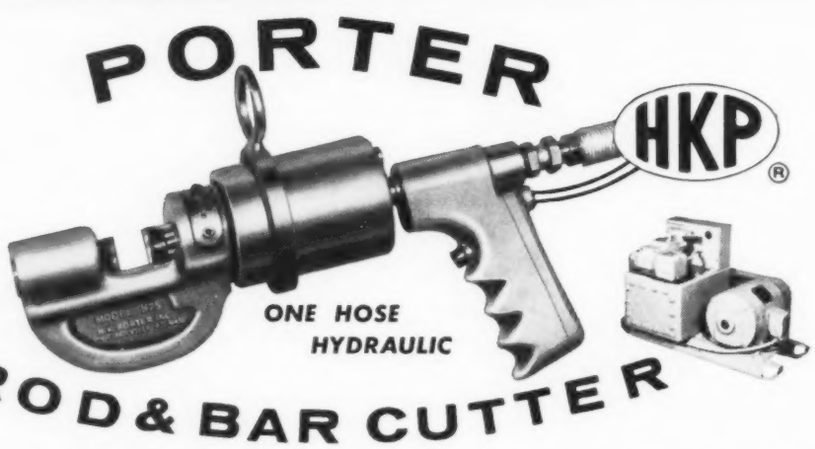
HOW TO CUT HIGH MAINTENANCE COSTS . . . SPEED CUTTING OPERATIONS

From rod and wire mills everywhere come reports that down-time for repairs is practically non-existent with the Porter Hydraulic. Add to this — *faster* cutting, and you have these vital ingredients for boosting your production. Two features found *only* in Porter Cutters make this efficiency possible.

CUTTER BLADES WITH MORE BEARING SURFACES .... WON'T BREAK DOWN!

Because blades are longer they have more bearing surfaces for *rigid* alignment, thus eliminating any side thrust which causes breakage.

Filtered air taken into the cylinder is forced out around the movable blade on each cut, eliminates danger of dirt reaching bearing surfaces causing oil leakage and wear.



A HYDRAULIC SYSTEM OF FOOL-PROOF DESIGN! One-hose design cuts replacement costs in half. Adjustable relief valve saves wear and tear by providing the correct pressure for any cutting job. Hydraulic oil is filtered by an easy-to-change 40 micron oil filter. And a safe 12-volt control switch on the cutterhead gives instant finger-tip control of the cutting action.

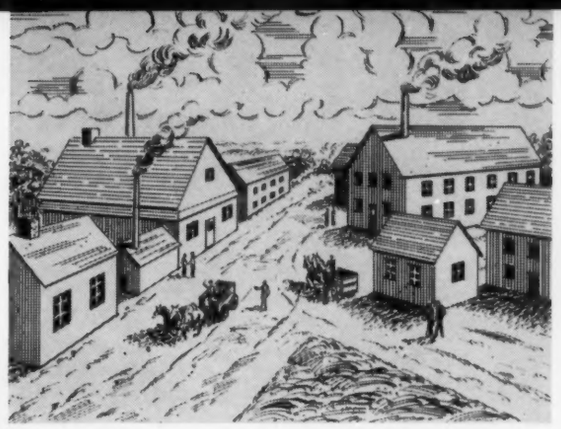
WRITE FOR ON-THE-JOB DEMONSTRATION OR ROD AND BAR CUTTER CATALOG

AVAILABLE NOW! 3 CUTTERHEADS with capacities up to 1⅜" steel rods. 5 HYDRAULIC POWER UNITS. Matched to your exact requirements. Specially designed heads for other non-cutting applications, such as punching, crimping, heading, forming.

H. K. PORTER, INC.,

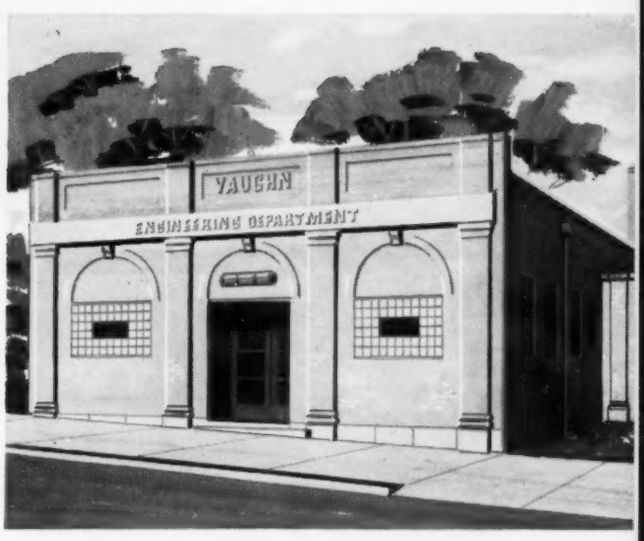
Somerville 43, Mass.

the PAST...



PRESENT

and FUTURE



# of BETTER COLD DRAWING for Industry

Modern cold drawing began in fact with the introduction of the Vaughn Motobloc in 1924—a great surge forward in the pace of Vaughn mechanical development that started with our first rod frame in 1871.

The Motobloc was followed by the Motoblox, and progress has accelerated steadily with ever-faster and more productive models to the present day, included in the world's only complete line of cold drawing equipment.

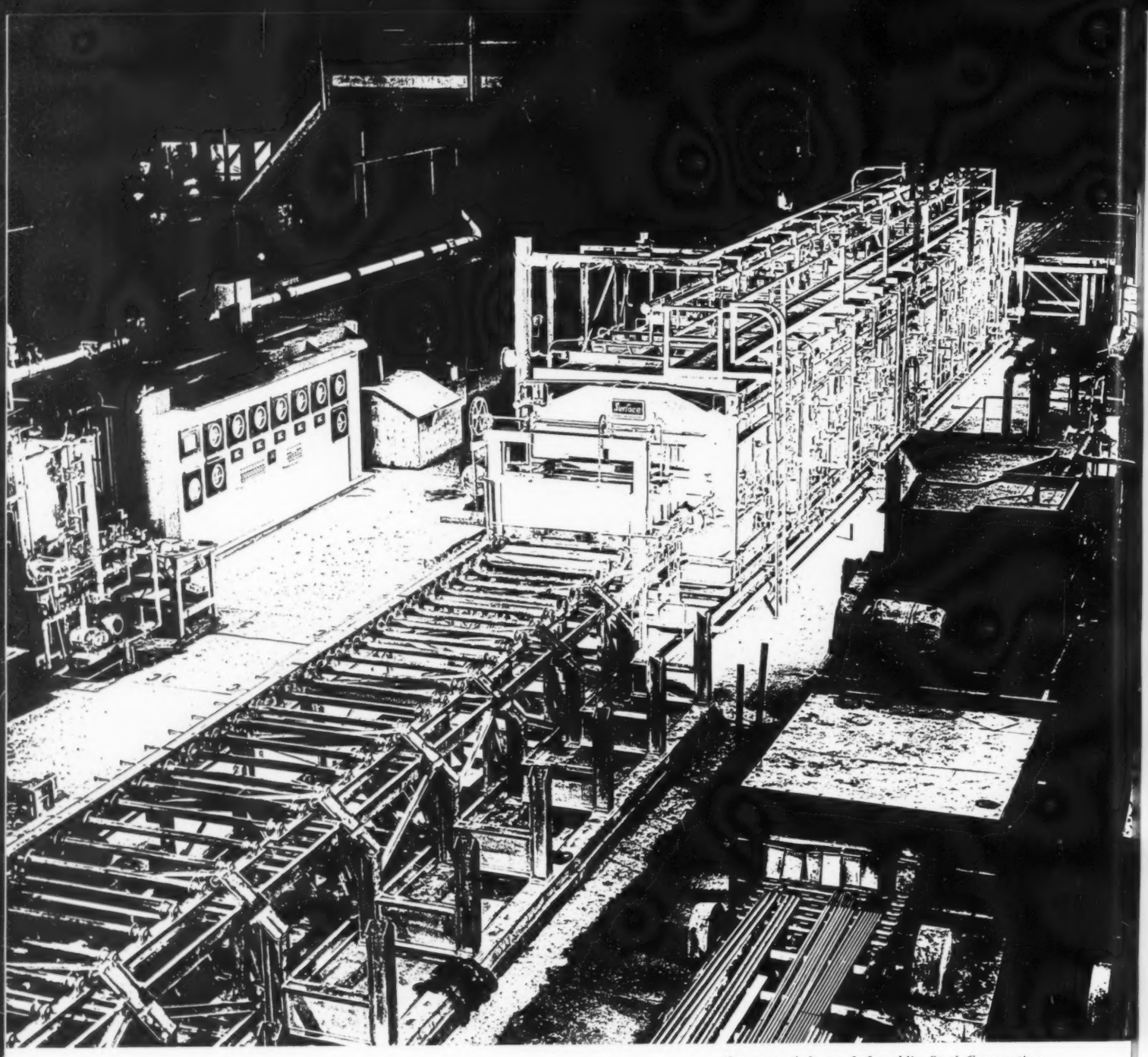
Tomorrow is on the drawing boards at Vaughn, with methods and machines that in their time will change again the thinking of an industry. That future is clearly defined by the accomplishments of four generations of continuous Vaughn leadership and the invaluable contributions of progressive wire, bar and tube manufacturers.

Let us work with you on your coming production requirements.

The VAUGHN MACHINERY COMPANY

CUYAHOGA FALLS, OHIO

COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys

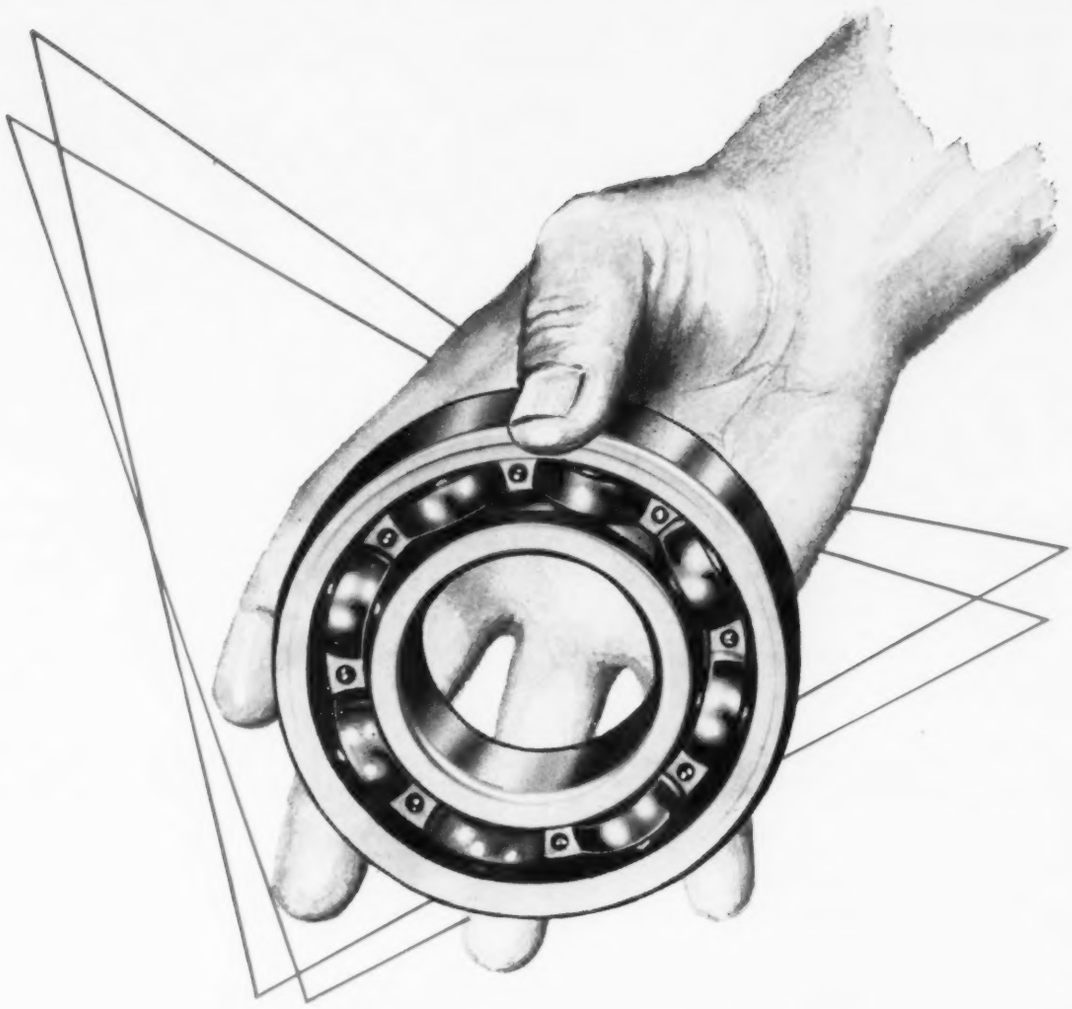


Courtesy of Jones & Laughlin Steel Corporation

Produces more steel and happier customers: Both Jones & Laughlin Steel Corporation and its customers have gained from this Surface furnace. For J&L, it affords continuous high production, uniformity through every bar in each load, accurate repeatability, and a variety of heating-cooling cycles. For J&L's customers, it delivers bar stock with the uniform microstructure which improves machining efficiency and profits. Address inquiries to 2404 Dorr St., Toledo 1, Ohio.

SURFACE

SURFACE COMBUSTION, Toledo 1, Ohio/ a division of Midland-Ross Corporation MR



HERE'S YOUR BEARING, SIR!

Those four words summarize the *Immediate Delivery* service you will get when you order bearings, bearing specialties, or transmission appliances from Berry Bearing. Out of a huge inventory of over 50,000 different items, regularly carried in stock, Berry can quickly fill your order--*right off the shelf.*

And, no plant, including yours, is much more than 5 miles or 27 minutes away from Berry's new main office or one of the 10 outlying branches throughout Chicagoland. Consequently, when you call Berry you can depend on--*immediate delivery*--on anything you need. And, for bearing engineering service...or...expert help in solving your bearing Value Analysis problems, don't hesitate to phone Berry--you'll get *immediate technical assistance,* at no cost to you.

BERRY BEARING COMPANY

All phones--DAnube 6-6800

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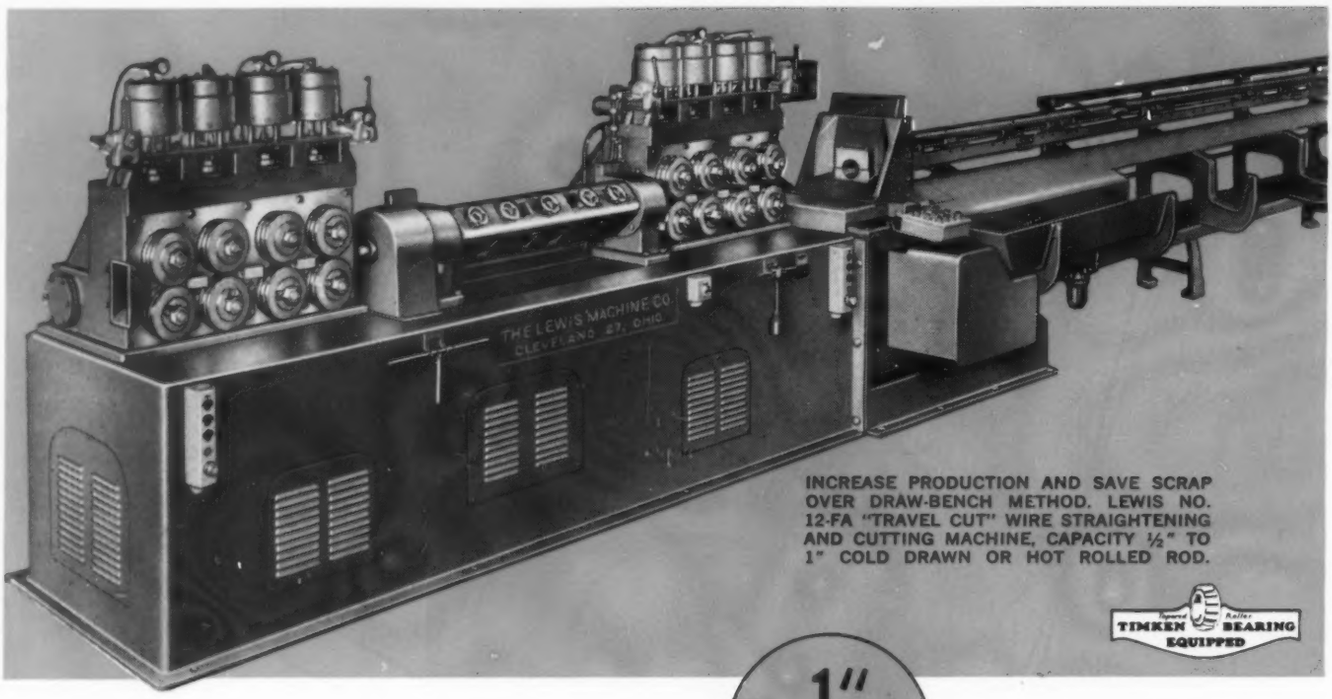
AURORA • JOLIET • OAK PARK • ROCKFORD • SKOKIE • SOUTHWEST • WAUKEGAN • CHICAGO HEIGHTS • GARY • HAMMOND



INCREASE PRODUCTION AND SAVE SCRAP OVER DRAW-BENCH METHOD. LEWIS NO. 12-FA "TRAVEL CUT" WIRE STRAIGHTENING AND CUTTING MACHINE, CAPACITY ½" TO 1" COLD DRAWN OR HOT ROLLED ROD.

Tapered Roller TIMKEN BEARING EQUIPPED

Now... straighten and cut 1" dia. rod FROM COILS at speeds up to 350 fpm.

HERE'S WHY IT CAN BE DONE

CUT-OFF Flying Shear Type. Pure crank motion for both cutting and traveling permitting high speeds with minimum shock.

ROTARY ARBOR Two-speed with dual-center straightening dies for faster, more accurate straightening over a wide range.

ROLL HOUSINGS Dual-range pushbutton operated pneumatic feed pressure for exact feed control and coil end pull-through without twisting.

LENGTH GAUGING Light pressure on electric trip switch actuates air clutch. Wire is gauged and released with positive moving mechanism . . . springs and latches have been eliminated.

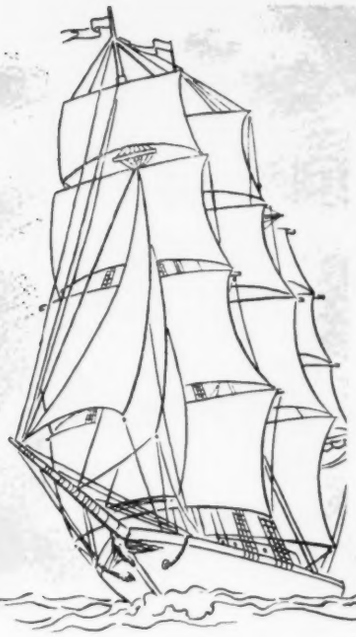
TRANSMISSION Positive sliding-gear type with eight feed speeds — 115 to 350 FPM.

Write for Brochure. Other models available to handle rounds from .012" to 1" dia. Shapes from 1/16 to 5/8" square, hex and flats.

THE LEWIS MACHINE COMPANY
A DIVISION OF CURTIS MFG. CO.
3441 EAST 76TH STREET • CLEVELAND 27, OHIO

Why Rust-Oleum is different—

and what this difference, backed by 35 years of industry proof, means to you!



A Sea Captain developed it . . . Industry proved it!

The original Rust-Oleum formula was developed nearly fifty years ago by Sea Captain Robert Fergusson, who became intrigued with the rust-stopping qualities of fish oil early in his career. Creating a *special treatment* for the fish oil, he used the *specially-processed fish oil* as the vehicle in combination with fine rust-inhibiting pigments. The result? A coating that actually *stopped rust* when applied directly over sound rusted surfaces, after scraping and wirebrushing to remove rust scale and loose rust. Possible, because the *specially-processed* fish oil penetrated the rust to bare metal. This was the birth of Rust-Oleum's *exclusive* 769 Damp-Proof Red Primer.

PROVED THROUGHOUT INDUSTRY FOR OVER 35 YEARS

Today, Rust-Oleum in its many systems and colors, has been proved throughout industry for over thirty-five years. This proof by leading industrial users is your assurance of savings in time, money, and metal. Economies made possible by the fact that Rust-Oleum 769 Damp-Proof Red Primer goes right over the sound rusted metal—usually eliminating costly surface preparations. And Rust-Oleum, in its various systems, resists rain, sun, fumes, heat, weathering, chemicals, etc., for lasting beauty over the years.

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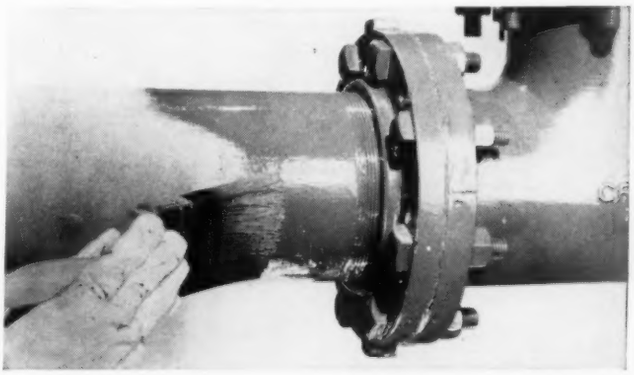
The Rust-Oleum New Color Horizons System introduces a new coating concept to industry. It combines four important factors: (1) the ability to stop rust, (2) smart, modern color harmony, (3) the durability to last and last, (4) ease of application that saves time, money, and metal. See how this system can bring lasting beauty to your plant, machinery, equipment, pipes, tanks, structural steel, fences, etc. Write for complete information or contact your nearby Rust-Oleum Industrial Distributor. He maintains complete stocks for prompt service.



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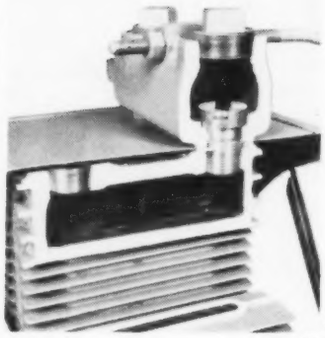

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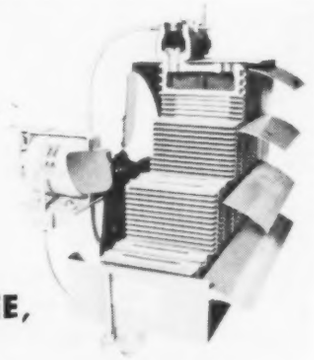

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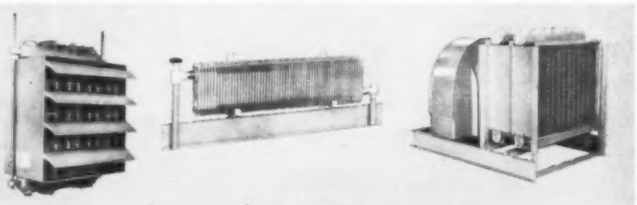

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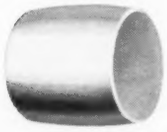

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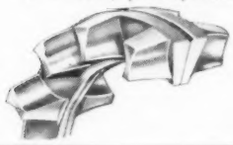

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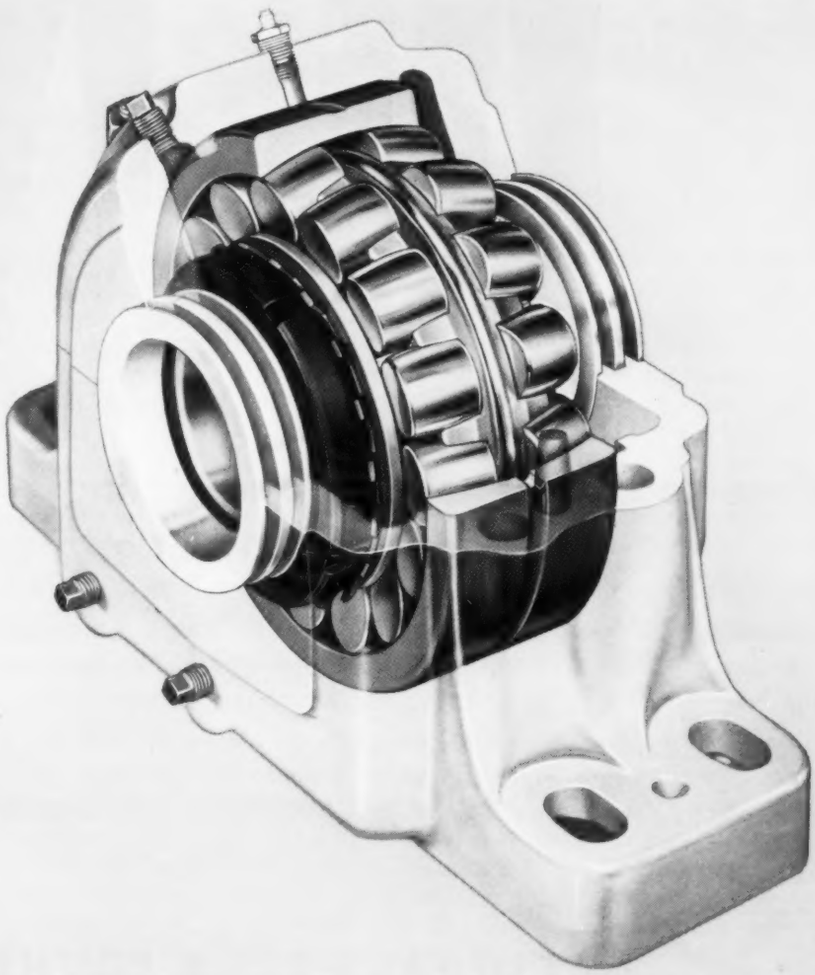

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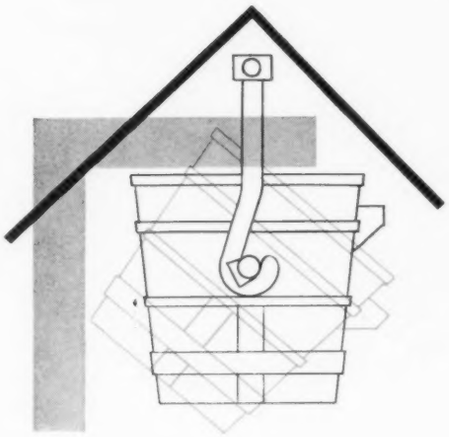

STEEL ANGLES

THE recent discussion on a possible increase in the price of steel, as a consequence of an automatic wage increase that went into effect on October 1, has centered the country's attention on this industry. It started with an exchange of letters between President Kennedy and the heads of 12 major steel companies, and was followed by another exchange between the President and David J. McDonald of the United Steelworkers of America. The President indicated the key role that steel plays in the economy as he stated in his letter to the steel companies: "Steel is a bellwether, as well as a major element in industrial costs. A rise in steel prices would force price increases in many industries, and invite price increases in others."

In reply to the President's letter, steel men quoted the report of Dr. Livernash of Harvard University, which was prepared for the Dept. of Labor. Dr. Livernash concluded: "Obviously while price policy can be debated in the short run, in the long run all cost increases must be met. Steel has done no more than this." Thus, it would seem that the Livernash report, a government document, indicates that the contribution of steel pricing to inflation has been exaggerated.

It should be pointed out that the study was undertaken after the 1959 steel strike and did not take into account the fact that the steel companies have not raised prices for the past 2½ years in spite of three wage increases. Thus, the statement which indicates that steel prices have just about advanced enough to cover costs no longer pertains since costs have gone up without corresponding price increases since 1960.

The companies in the industry have indeed tried to hold the line against inflation through the absorption of wage increases. This was only possible as a result of a full-scale campaign to increase productivity and efficiency and thus reduce costs. Most companies were successful in their endeavors while they enjoyed a high rate of operations, however, from July of 1960 to the third quarter of 1961 the rate of operations has been substantially below that which was hoped for when the contract was signed with the steelworkers in January, 1960.

As a result of a lower rate of activity, many of the steel companies, particularly those who have not had the funds to modernize plant and equipment extensively, have found themselves squeezed by mounting costs. Profits in many instances have been substantially reduced and in a few cases have disappeared altogether. During the first six months of 1961 some of the larger, more efficient companies have failed to earn their dividends for the first time in many years.

To complicate the situation further, a number of companies have been pressed by foreign competition, which although it may not represent more than a four per cent factor in the over-all picture has been a major problem to a few companies.

The steel companies have made their contribution to the stability of the economy and now it is the turn of the United Steelworkers. President Kennedy has asked them to keep their demands within the limits of advancing productivity. This was done by letter and again through Dr. James Tobin, a member of the President's Council of Economic Advisors. In a speech to the union economists he restated the President's point on wage demands and productivity.

If both sides act on the request of the President, it would seem that the wage negotiation will be based principally on productivity increases. Thus one can see the need for a better understanding of productivity, a measure which will determine the rate of increase with a high degree of accuracy and a constantly increasing productivity.

If productivity is not accurately measured, and the present man-hour measurement is conceded by many to be deficient, it is possible that some companies may be paying more than is warranted by true productivity increases and thus their profit position will be injured. This would be most unfortunate from the particular company's point of view since profits are necessary for the very existence of any private company in our economic system. Further, it would be unfortunate for the government since profits are the source from which it draws a large share of its taxes. A low rate of profits, or still worse a loss, means less in tax revenue for the operations of government.

All are in agreement on the need for constantly increasing productivity. It is the basis of our standard of living, our wage and profit rates and our ability to meet foreign competition.

This upward trend in productivity must be maintained, and one of the essential means to this end is the continual modernization of industrial plant and equipment. Much has been done in this regard since the close of World War II; however, much still remains to be done. Obsolete equipment must be replaced and here the government can be of substantial help by modernizing the tax laws to allow for sufficient depreciation charges in place of those which are now inadequate. Such a move would help the productivity trend which in turn would allow the companies to hold the line on costs. ▲

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AISE STANDARD NO. 1-A

A-C MILL MOTOR STANDARDS

(Tentative)

September, 1961

Published by
Association of Iron and Steel Engineers
1010 Empire Building
Pittsburgh 22, Pa.

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1. General
   a. The widespread usage of AISE d-c mill motor, described in AISE Standard No. 1 has led to many requests for rugged a-c mill motors which could be used for the same applications as the d-c mill motor but where the availability of a-c power makes more economical the use of an a-c motor.
   b. It is expected that the motor will be applied on mill auxiliaries and electric overhead traveling cranes. The development of better a-c crane controls than previously available is an important factor in deciding on the new standard.
   c. Standardization is to cover only those areas necessary for interchangeability of the motors between various manufacturers. These are (Figure 1):
      (a) Capacity ratings: speed, enclosure and temperature rise.

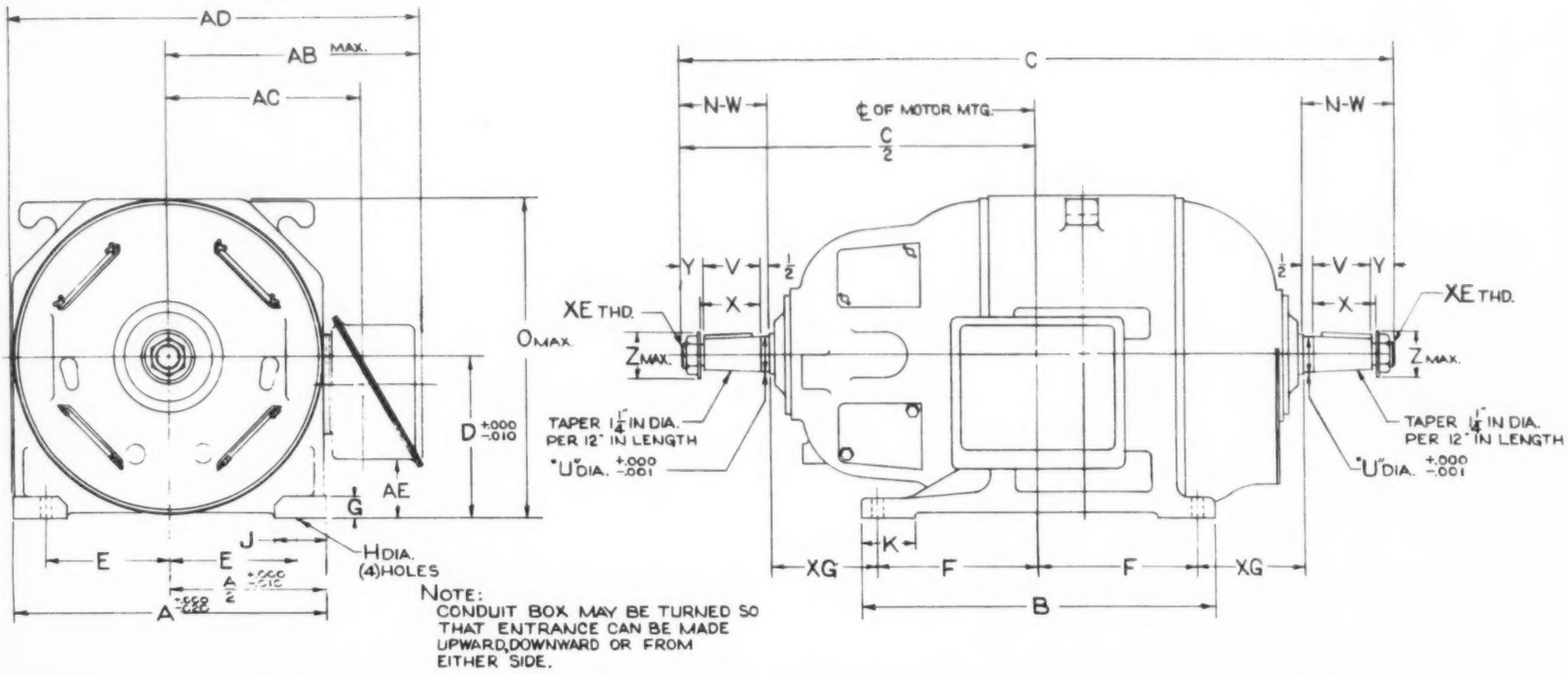


Figure 1 — AISE Standardized A-C Mill Motor Dimensions.

MOTOR FRAME AISE	HP	SPEED	KEYWAY WIDTH	KEYWAY DEPTH	KEYWAY LENGTH	A	B	C	D	E	F	G	H	J	K	O	U	V	X	Y	Z	AB	AC	AD	AE	N-W	XE	XG	BEARINGS AFBMA
AC 1	5	1200	1/2	1/4	2 5/8	15	16 5/8	33 3/4	7	6 3/4	7 5/16	3/4	11/16	2 3/4	3	14	1 3/4	2 3/4	3	1 3/16	2 9/16	11 3/16	9 1/8	18 3/16	0		4 7/16	1-8	5 1/8	50BC02
AC 2	10	1200	1/2	1/4	2 5/8	15	16 5/8	33 3/4	7	6 3/4	7 5/16	3/4	11/16	2 3/4	3	14	1 3/4	2 3/4	3	1 3/16	2 9/16	11 3/16	9 1/8	18 3/16	0		4 7/16	1-8	5 1/8	50BC02
AC 4	20	1200	1/2	1/4	2 5/8	17	17 3/8	35 1/2	8	7 3/4	7 11/16	13/16	11/16	3 1/8	3 3/8	16	1 3/4	2 3/4	3	1 3/16	2 9/16	13 3/16	10 11/16	21 3/16	0		4 7/16	1-8	5 5/8	50BC03
AC 8	40	1200	1/2	1/4	3 3/4	19	21 3/8	42 3/8	9	8 1/2	9 7/16	1	13/16	3 1/4	3 3/8	18 3/16	2 1/2	3 3/4	4	1 3/8	3 1/4	16 1/2	12 7/8	25 1/2	1		5 5/8	1 1/2-8	6 1/8	70RJ02
AC 12	60	1200	1/2	1/4	3 3/4	21	22 3/4	45 1/4	10	9 1/2	10 1/8	1 1/4	13/16	3 1/2	3 3/4	20 3/16	2 1/2	3 3/4	4	1 3/8	3 1/4	17 5/8	14	27 5/8	1		5 5/8	1 1/2-8	6 7/8	70RJ02
AC 18	90	900	3/4	1/4	4 1/4	26	28 3/4	55 7/16	12 1/2	11 3/4	12 7/8	1 5/16	1 1/16	4 7/8	5 1/8	24 5/8	3 1/4	4 1/4	4 1/2	1 5/8	4 1/4	21 1/2	16 15/16	34 1/2	2 1/16		6 3/8	2 1/4-8	8 15/32	90RJ02
AC 25	125	900	3/4	1/4	4 1/4	30	33 1/2	64 3/8	14 1/2	13 1/2	15 1/4	1 5/16	1 3/16	4 7/8	5 1/8	28 5/8	3 5/8	4 3/4	5	1 3/4	4 9/16	23 1/2	18 15/16	38 1/2	3 9/16		7	2 1/2-8	9 15/16	95RJ02
AC 30	150	900	3/4	1/4	4 1/4	30	33 1/2	64 3/8	14 1/2	13 1/2	15 1/4	1 5/16	1 3/16	4 7/8	5 1/8	28 5/8	3 5/8	4 3/4	5	1 3/4	4 9/16	23 1/2	18 15/16	38 1/2	3 9/16		7	2 1/2-8	9 15/16	95RJ02
AC 40	200	720	1	3/8	4 3/4	35	38 7/8	72 5/8	17	15 3/4	17 11/16	1 1/2	1 5/16	4 7/8	6	33 5/8	4 1/4	4 3/4	5	1 7/8	5 1/8	26	21 7/16	43 1/2	4 9/16		7 1/8	3-8	11 1/2	110RJ03
AC 50	250	720	1	3/8	4 3/4	35	38 7/8	72 5/8	17	15 3/4	17 11/16	1 1/2	1 5/16	4 7/8	6	33 5/8	4 1/4	4 3/4	5	1 7/8	5 1/8	26	21 7/16	43 1/2	4 9/16		7 1/8	3-8	11 1/2	110RJ03

(b) Mounting dimensions: shaft height, bearing size, shaft extension and over-all volumetric dimensions as referred to in the mounting dimensions.

(c) Primary and secondary characteristics.

(d) Torque and overspeed.

d. The AISE a-c standard mill motor will not be interchangeable with the AISE d-c standard mill motor.

e. NEMA Standards No. MG-1 shall apply unless otherwise indicated.

f. The motor designation of each frame shall consist of the letters AC (for alternating current) plus a number which shall be one fifth the horsepower of the 1-hr, totally-enclosed, nonventilated rating.

g. The word "shall" in this specification is mandatory.

2. Ratings

a. Ratings of the motor are given in Table I. Speeds were selected as follows:

(a) Up through 60 hp, 1200 rpm.

(b) Above 60 through 150 hp, 900 rpm.

(c) Above 150 hp, 720 rpm.

b. Basic rating is the 1-hr, totally-enclosed, nonventilated (TENV) 85-C rise by resistance. (The 85-C temperature rise by resistance is equivalent to the 75-C rise by thermometer procedure used in rating the d-c mill motor.)

c. Other ratings are as follows:

(a) One-hr, protected, self-ventilated, 80-C rise by resistance. This rating shall be 125 per cent the TENV, 1-hr rating.

(b) Continuous, protected, self-ventilated, 80-C rise by resistance. This rating shall be the same as the TENV, 1-hr rating.

(c) Continuous, protected, force-ventilated, 80 C rise by resistance. This rating shall be 125 per cent the TENV, 1-hr rating.

(d) Continuous, enclosed, force-ventilated, 80-C rise by resistance. This rating shall be the same as the TENV, 1-hr rating.

d. The breakdown torque shall be not less than 325 per cent nor more than 425 per cent of the 1-hr, TENV rating at rated voltage and frequency.

e. The primary power shall be 440-volt, 3-phase, 60 cycle.

f. Secondary electrical characteristics shall be as shown on Table I.

g. The variation allowed on the secondary voltages shall be plus or minus 10 per cent.

h. Motors shall be designed to have an acceleration rate which will enable the motor to reach 100 per cent speed using the 1-hr, TENV-rated torque with no connected load in a time as small as possible with a maximum of 0.7 sec.

i. The maximum allowable speed of the motor shall be 200 per cent of its rated speed.

j. All motors shall be designed so that they can be used as TENV, self-ventilated and force-ventilated motors without internal modifications. Direction of internal air flow shall be toward the collector end.

k. Protected, self-ventilated motor design shall be accomplished by removing all covers below the horizontal centerline.

l. It shall be permissible to convert a TENV or self-ventilated machine to a force-ventilated machine by using a different or modified end bracket or cover. Brackets for ventilating openings shall be designed so they can be turned in 90-degree increments. Air requirements and dimensions for force-ventilation openings are given in Figure 2.

3. Dimensions

a. The outline dimensions of the standard a-c mill motor and accessories shall be as shown in Figure 1.

4. Details

a. Mill motors shall be designed for rugged heavy-duty service and shall be capable of withstanding appreciable impact loads.

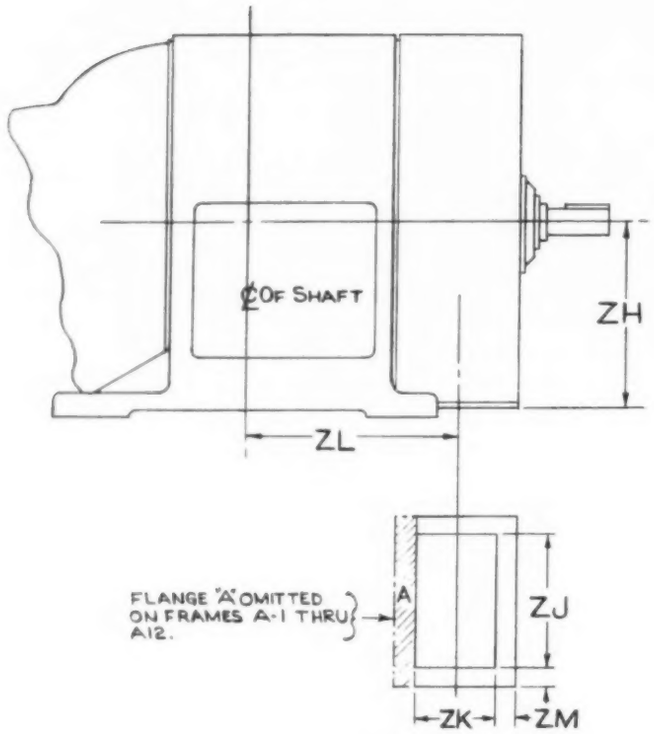
b. Lifting lugs shall be cast, welded or bolted and so located that the top of the lug will not extend above the top limit of the 0 dimension or sidewise beyond the A dimension.

c. The motors have been designed to allow the user to turn the motor end-for-end if so desired.

TABLE I

AISE Standard A-C Mill Motor Ratings and Electrical Characteristics

AISE motor frame	Rpm	TENV, 1-hr full load torque, lb-ft	Temperature rise and motor rating					Secondary electrical characteristics		
			85 C, TENV, 1-hr	80 C, protected self-ventilated, 1-hr	80 C, protected self-ventilated, continuous	80 C, protected force-ventilated, continuous	80 C, enclosed force-ventilated, continuous	Secondary voltage	Secondary amp	Resistance ohms
AC 1	1200	23	5	6.25	5	6.25	5	140	19	3.50
AC 2	1200	46	10	12.5	10	12.5	10	195	26.5	3.50
AC 4	1200	92	20	25	20	25	20	265	38	3.50
AC 8	1200	184	40	50	40	50	40	250	75	1.75
AC 12	1200	276	60	75	60	75	60	300	92	1.75
AC 18	900	540	90	112	90	112	90	260	162	0.875
AC 25	900	750	125	156	125	156	125	305	190	0.575
AC 30	900	895	150	188	150	188	150	340	207	0.875
AC 40	720	1490	200	250	200	250	200	275	335	0.437
AC 50	720	1857	250	312	250	312	250	310	375	0.437



NOTE:
AIR DUCT MAY BE TURNED SO THAT ENTRANCE CAN BE MADE UPWARD, DOWNWARD OR FROM EITHER SIDE.

FRAME NO.	HP	ZH	ZJ	ZK	ZL	ZM	CFM	PRESSURE DROP IN. OF WATER
AC1	5	6 1/2	6 1/2	3 3/8	9 5/16	3/4	100	3/4
AC2	10	6 1/2	6 1/2	3 3/8	9 5/16	3/4	125	3/4
AC4	20	7 1/2	7 3/4	3 1/2	10 1/8	3/4	150	3/4
AC8	40	8 1/2	9 3/8	4	12 1/2	3/4	225	1
AC12	60	9 1/2	10 5/8	4 1/2	13 11/16	3/4	325	1 1/4
AC18	90	12	13	5 1/4	17 3/8	1"	600	1 1/4
AC25	125	13 7/8	17	6	19 3/16	1"	775	1
AC30	150	13 7/8	17	6	19 13/16	1"	900	1 1/2
AC40	200	16 3/8	22	6	23 7/16	1"	1075	1 1/4
AC50	250	16 3/8	22	6	23 7/16	1"	1250	1 1/2

Figure 2 — AISE Standardized A-C Mill Motor Air Requirements and Dimensions.

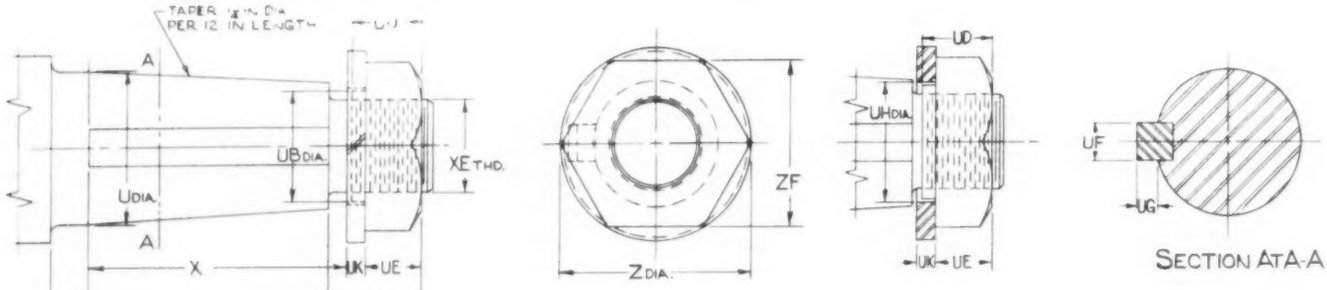
d. The motors are designed for flexible coupling applications and are not designed for back axle service.

e. A conduit box for primary and secondary leads shall be furnished with a bolted-on blank plate on the conduit entrance side. The conduit box shall be designed so that entrance can be made from any horizontal or vertical direction by rotating the box. Conduit box dimensions are shown in Figure 1.

f. The leads going through the motor frame shall be sealed.

g. Standards on shaft nuts and lock washers are shown in Figure 3.

Figure 3 — AISE Standardized A-C Mill Motor Shaft Nut and Lock Washer Dimensions.



MOTOR FRAME AISE	N	U	UB	UD	UE	UF	UG	UH	V	X	XE	Y	Z	ZF	UK
AC1	4 7/16	1 3/4	1 3/8	7/8	11/16	1/2	1/4	1 9/16	2 3/4	3	1-8	1 3/16	2 9/16	2	1/4
AC2	4 7/16	1 3/4	1 3/8	7/8	11/16	1/2	1/4	1 9/16	2 3/4	3	1-8	1 3/16	2 9/16	2	1/4
AC4	4 7/16	1 3/4	1 3/8	7/8	11/16	1/2	1/4	1 9/16	2 3/4	3	1-8	1 3/16	2 9/16	2	1/4
AC8	5 5/8	2 1/2	2	1 1/16	7/8	1/2	1/4	2 1/8	3 3/4	4	1 1/2-8	1 3/8	3 1/4	2 3/4	1/4
AC12	5 5/8	2 1/2	2	1 1/16	7/8	1/2	1/4	2 1/8	3 3/4	4	1 1/2-8	1 3/8	3 1/4	2 3/4	1/4
AC18	6 3/8	3 1/4	2 3/4	1 5/16	1 1/8	3/4	1/4	2 13/16	4 1/4	4 1/2	2 1/4-8	1 5/8	4 1/4	4	1/4
AC25	7	3 5/8	2 15/16	1 7/16	1 1/4	3/4	1/4	3 1/32	4 3/4	5	2 1/2-8	1 3/4	4 9/16	4 1/4	1/4
AC30	7	3 5/8	2 15/16	1 7/16	1 1/4	3/4	1/4	3 1/32	4 3/4	5	2 1/2-8	1 3/4	4 9/16	4 1/4	1/4
AC40	7 1/8	4 1/4	3 1/2	1 9/16	1 3/8	1"	3/8	3 9/16	4 3/4	5	3-8	1 7/8	5 1/8	4 3/4	1/4
AC50	7 1/8	4 1/4	3 1/2	1 9/16	1 3/8	1"	3/8	3 9/16	4 3/4	5	3-8	1 7/8	5 1/8	4 3/4	1/4

The A-C Mill Motor—A New AISE Standard

by M. B. ANTRIM, Manager,
Engineering and Construction Div., Lukens Steel Co., Coatesville, Pa.

The development of an a-c standard mill motor was accomplished by a joint committee of mill users and motor manufacturers. Steel plant men outlined requirements and practice, motor designers set what was economically practical. The resultant design should be of great value to the steel, crane and other industries.

ON April 19, 1960, the Mill Motor Subcommittee of the Standardization and Research Committee of the AISE met at the Pittsburgh headquarters to consider the need for a possible new standard concerning wound-rotor a-c induction motors used in steel mill service.

Faced with the need for a rugged, low maintenance cost, a-c motor which would eliminate the initial cost and maintenance cost of d-c conversion equipment as indicated by AISE representatives on the mill motor committee, together with the recent availability of improved control for a-c motors, especially in regard to crane service, the Mill Motor Subcommittee voted unanimously to attempt the standardization of such a motor. It was expected that the new standard motor, if one could be evolved, would be applied not only on cranes but also on mill auxiliaries.

A policy was approved covering the scope of the proposed standardization limiting this to only those items affecting interchangeability thus aiding competition and progress in the best interests of all.

In line with this policy the following areas were covered:

1. Capacity ratings: speed; enclosure; and temperature rise.
2. Mounting dimensions: shaft type; bearing size; shaft extension; and over-all volumetric dimensions.
3. Primary and secondary electrical characteristics.
4. Torque and overspeed.

The committee decided early that nothing would be gained in making the new a-c standardized motor interchangeable with the existing AISE d-c standard mill motor. However, in this connection the a-c standardized motor, as finally evolved with the exception of the conduit box, will fit into the same space volumetrically as the d-c mill motor of equivalent horsepower and in most cases the next larger size a-c standardized motor will fit into the space.

Standards concerning variations from rated voltage, variation from rated frequency and the combined effect of variation of voltage and frequency as well as the standard for high-potential test requirements are the NEMA Standard MG-1.

The basic horsepower ratings and speeds are those of the 1-hr, totally-enclosed, nonventilated ratings. Accordingly, a designation for the new standardized line of motors was developed which consists of the prefix letters, A-C followed by a number which is one fifth of the basic horsepower capacity.

The basic ratings selected are ten in number and are shown in Table I of the A-C Mill Motor Standard.

It will be noted that from 5 through 60 hp, 1200 rpm is the synchronous speed, from 90 through 150 hp, 900 rpm is the synchronous speed and from 200 through 250 hp, 720 rpm is the synchronous speed.

The basic ratings, the 1-hr, totally-enclosed, nonventilated 85-C rise by resistance ratings, are shown in column 4 of the same table. The 85-C temperature rise by resistance is equivalent to the 75-C rise by thermometer procedure used in rating the d-c mill-type motor. Full-load torque ratings corresponding to the standard horsepower ratings of these motors are shown in column 3.

The standard horsepower capacities selected have ratios of each rating to the next lower horsepower which vary from 1¼ to 1 for the largest horsepowers up to two to one for the lower horsepowers. Corresponding torque ratios also vary between 1¼ to 1 for the larger horsepowers up to two to one for the smaller horsepowers notwithstanding the speed changes.

During the course of standardization many communications were received from machinery builders, consulting engineering firms and motor and control manufacturers concerning the synchronous speeds to be selected for the basic horsepower ratings. This correspondence was equally divided, 50 per cent requesting higher speeds for the basic ratings and 50 per cent asking for lower speeds for these ratings. Accordingly the committee feels that in the selection of standard capacities and speeds, it has apparently followed a conservative middle-of-the-road course.

In addition to the basic rating, four other motor ratings have been standardized. These are the 1-hr, protected, self-ventilated 80-C rise by resistance rating, shown in column 5 of Table I of the A-C Mill Motor Standard, whose horsepowers are 125 per cent of the basic horsepower ratings; the continuous, protected, self-ventilated 80-C rise by resistance rating shown in column 6 of the same table whose ratings are exactly equivalent to the basic rating; the continuous, protected, forced-ventilated 80-C rise by resistance rating shown in column 7, whose ratings are also 125 per cent of the basic rating; and the continuous, enclosed, forced-ventilated 80-C rise by resistance rating shown in column 8, whose ratings are exactly equivalent again to the basic ratings. In connection with these ratings, all of the motors are designed so that they can be used as totally-enclosed, nonventilated, self-ventilated or forced-ventilated motors without internal modifications. The direction of air flow through the motor is toward the collector end. Conversion from totally-enclosed, nonventilated to protected, self-ventilated construction can be accomplished by removing all covers below the horizontal centerline of these motors.

Full-load motor torques in lb-ft are specified in column 3 of Table I of the A-C Mill Motor Standard; however, breakdown torques have been standardized at no less than 325 per cent nor more than 425 per cent of the full-load torques at rated voltages and frequency.

As a matter of information it should be pointed out that the standard NEMA minimum breakdown torque is 275 per cent.

The selection of 440-volt, 3-phase, 60-cycle alternating current for the standard primary power supply for this line of motors was adopted and the secondary electrical characteristics resulting from this selection, together with motor design, are standardized as shown in the last three columns of Table I of the A-C Mill Motor Standard. Secondary voltage variations are standardized at plus or minus ten per cent from the figures shown.

All of these new a-c motors will be designed to have an acceleration rate which will enable them to reach 100-per cent speed using the 1-hr, totally-enclosed, nonventilated rated torque with no connected load in as small a time as possible with, however, a maximum allowable time of 0.7 sec. While the d-c mill motor standard design provides an acceleration rate of 0.3 sec, it must be realized that the torque capacities of the d-c and a-c motors are entirely different and also the a-c synchronous speeds are in all cases higher than the equivalent d-c motor speeds.

The maximum allowable motor speed for this new line of motors is 200 per cent of rated synchronous speed. The NEMA maximum overspeed is 150 per cent. In this connection an insulation problem is produced by this requirement. At 200 per cent of rated speed, the motor with the highest secondary voltage in the standardized line will generate 1020 volts which, of course, will be applied to the slip rings, wound-rotor leads and control resistors. On the other hand control requirements for high-speed lowering indicated the use of 180 per cent of rated speed in some cases, and the possibility of motor damage due to overspeed produced by an overhauling load and a faulty brake cannot be ignored.

The outline dimensions of the new a-c standardized motors are shown in Figure 1 of the A-C Mill Motor Standard.

It is of interest to point out that motor mounting bolt holes are provided in the motor feet in such a way that motor mounting bolts whose length, including the bolt head, is five times the bolt diameter can be inserted into the mounting feet without clearance difficulty between the bolt head and the motor end bracket. The minimum motor mounting bolt diameter is ⅝ in.

Shaft sizes have been selected to conform in all cases to the standard shaft diameters now used on the d-c mill motor line thus allowing the use of existing couplings. All shafts applied to this new line of motors fall within a maximum design stress of 5500 psi. The motors are all designed for flexible coupling applications and are not designed for direct pinion or belted service. It will be noted that ball bearings are utilized in the 5, 10 and 20-hp motors, or the three smallest ratings of the line; roller bearings are used in the remainder of the motors, these being of the 200 series with the exception of the two largest motors; the 200 and 250-hp ratings which use 300-series roller bearings. All bearings have been applied to supply in excess of a thrust capacity of two lb per horsepower as related to the motor on which they are applied.

Also, to be noted in Figure 1, as specified in the standard, lifting lugs shall be cast, welded or bolted on these motors and so located that the top of the lug will not extend beyond the top limit of the "O" dimension or sideways beyond the "A" dimension. Tolerance limits on the "A" dimension indicate that the sides of the feet of these motors are machined providing inter-

Figure 1 — The stator frame and winding of a prototype a-c motor are illustrated.

changeability without loss of line-up.

Spacing of the shaft ends, mounting holes and conduit box symmetrically about the side view centerline of the motor make it possible to turn the motor end for end if so desired.

Figure 3 of the A-C Mill Motor Standard shows the detail of the tapered shaft ends for each rating. This detail is exactly the same as the d-c mill motor except that a standard lock washer is utilized with the shaft end nut.

Figure 2 of the A-C Mill Motor Standard shows the information required for forced ventilation of this line of motors.

It is possible to convert a totally-enclosed, nonventilated or self-ventilated motor to a forced-ventilated motor by using a modified end bracket. These end brackets are so designed that they can be turned 360 degrees in 90-degree increments. Also, the size of air openings and the pressure drop through the machine, in in. of water, are given as well as the cfm air requirements for each rating.

The standard conduit box supplied for combined primary and secondary leads will be furnished with a bolted-on blank plate on the conduit entrance side. This conduit box is designed so that entrance can be made from any horizontal or vertical direction by rotating the box in 90-degree increments. The leads from this box into the motor frame are sealed at their entrance to the motor.

A number of motors similar to this type with a rugged, heavy-duty design capable of withstanding appreciable impact loads have already been built for use on cranes supplied to the United States Steel Corp. for their Gary plate mill.

Figure 1 shows a view of the stator frame and winding of one of these motors. Figure 2 shows the wound-rotor armature. Figure 3 shows the detail of the slip ring brush rigging. Figure 4 shows a completed view of the completely assembled motor from the conduit box side. Figure 5 shows a view of the completely assembled motor from the opposite side.

In conclusion it should be stated that the foregoing has been prepared as the Association of Iron and Steel Engineers Standard No. 1-A (A-C Mill Motor Standards) and has been submitted to the Board of Directors of the AISE for their approval. This approval has been granted and the standard will now be circulated to the membership of the Association. Effective Sunday Sept. 25, 1961, it is a Tentative Standard for one year's time. During this year it is hoped that there will be many constructive suggestions from the membership of the AISE so that any changes which are necessary can be made before the end of the 1-year tentative period, after which it becomes a firm Association of Iron and Steel Engineers Standard.

This standard was formulated by the Mill Motor

Figure 2 — The armature and shaft are designed for heavy-duty applications.

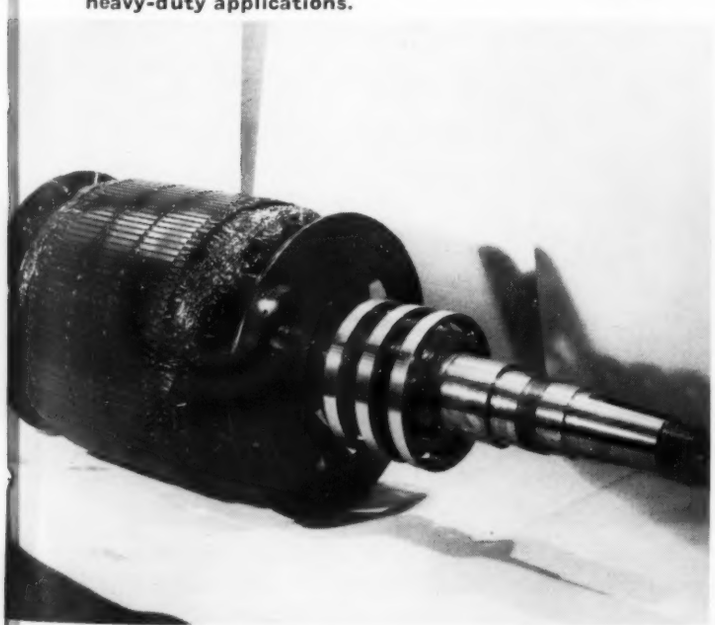


Figure 3 — The slip ring brush setup was designed to provide effective commutation.

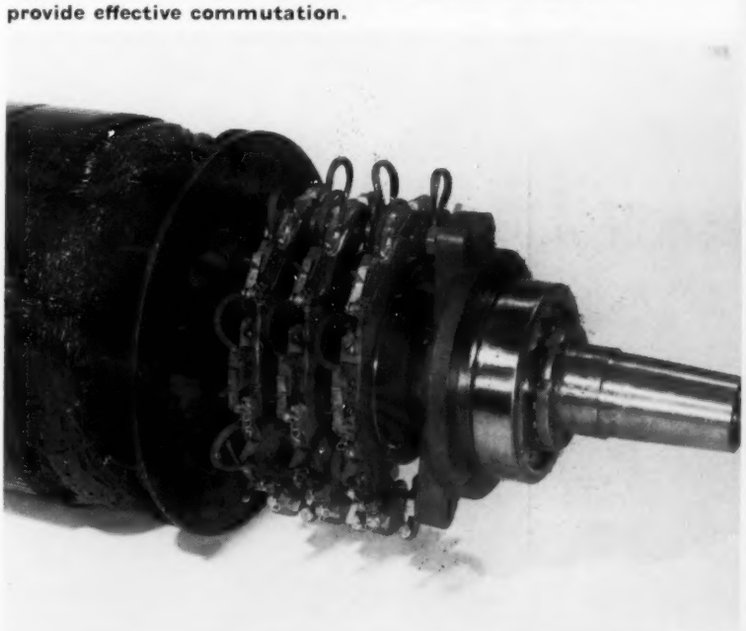


Figure 4 — The motor leads are protected by a conduit box.

Figure 5 — The end bells are of heavy-duty construction.

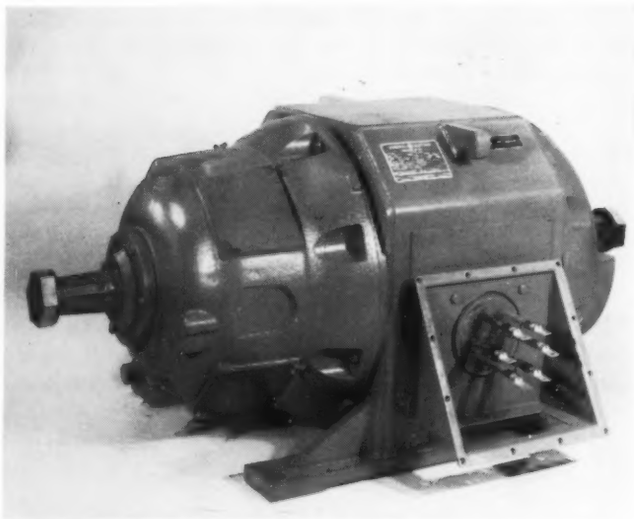


Figure 6 — The motor leads are sealed by an epoxy to prevent moisture infiltration.

Committee which, besides the author as Chairman, consisted of:

J. G. Mitchell, Superintendent, Electrical Dept., The Steel Co. of Canada, Ltd. (Vice Chairman)

E. D. Schlup, Chief Electrical Engineer, Armco Steel Corp.

H. H. Angel, Electrical Engineer, Construction Engineering Dept., Bethlehem Steel Co.

L. L. Quinlan, Electrical Superintendent, Indiana Harbor Works, Inland Steel Co.

J. T. Bradford, Jr., Electrical Control Engineer, Jones & Laughlin Steel Corp.

L. M. Ripple, Assistant Chief Engineer, Cleveland Works, Republic Steel Corp.

I. N. Tull, Chairman, Electrical Committee, Republic Steel Corp.

R. L. Livingston, Chief Electrical Engineer, United States Steel Corp.

J. E. Bodoh, General Electrical Supervisor, Gary Works, United States Steel Corp.

S. T. Mentzel, Design Engineer, Electrical, Gary Works, United States Steel Corp.

I. E. Madsen, Research & Standards Engineer, Association of Iron and Steel Engineers

The rapid formulation of this Standard (it required exactly one year) was made possible through the cooperative efforts of the Design Subcommittee of the Mill Motor Committee who are:

J. H. Behm, Manager, Production Engineering, Medium A-C Motor and Generator Dept., General Electric Co.

Sam Rifkin, Supervising Engineer—Materials Handling, Systems Sales and Engineering Operation, General Electric Co.

H. O. Poland, Chief Engineer, Motor and Generator Div., Harnischfeger Corp.

W. H. Formhals, A-C Motor Engineering Manager, Westinghouse Electric Corp.

F. L. Reed, Electrical Engineer, Westinghouse Electric Corp.

H. A. Zollinger, Engineer, in charge, Materials Handling, Westinghouse Electric Corp.

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Howard E. Jordan, A-C Project Engineer, Research, Development and Engineering Dept., Reliance Electric and Engineering Co.

We should like to thank all of these men both personally and in behalf of the AISE for their excellent cooperation and understanding in this project.

Automated Structural Rolling Facilities at South Works of U. S. Steel

by V. H. LINDBERG
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Works Chief Engineer
South Works
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. . . . an attempt to minimize human effort and to remove the need for human decision making, insofar as is possible, during the processing of structural shapes has resulted in the use of a concept of total system control. This control concept has led to: higher consistent quality; higher output capability; a decrease in equipment abuse; and ease of operation . . . .

ON March 6, 1956, the South Works plant of the United States Steel Corp. was authorized to proceed with construction of a new blooming and structural mill to replace old facilities which had progressively deteriorated to such an extent that continuous operation could not be assured. Figure 1 depicts the general layout of the original area in relation to the new.

The old facilities, built in 1905 to 1911, consisted of:

1. A 35-in. blooming mill.
2. An 8-stand, 22-in. cross country-type structural mill.
3. A 40-in. blooming mill and soaking pits.
4. A 32-in. breakdown mill and a 3-stand, 3-high 28-in. structural mill.

The new principal equipment areas are:

1. A 53-in. primary mill.
2. A 34-in. secondary mill.
3. Finishing and handling facilities.

Figure 2, showing a scale model of the new mill, enables one to visualize the facilities mentioned in relation

Figure 1 — The new mill facilities and handling areas occupy much less space than the old mill.

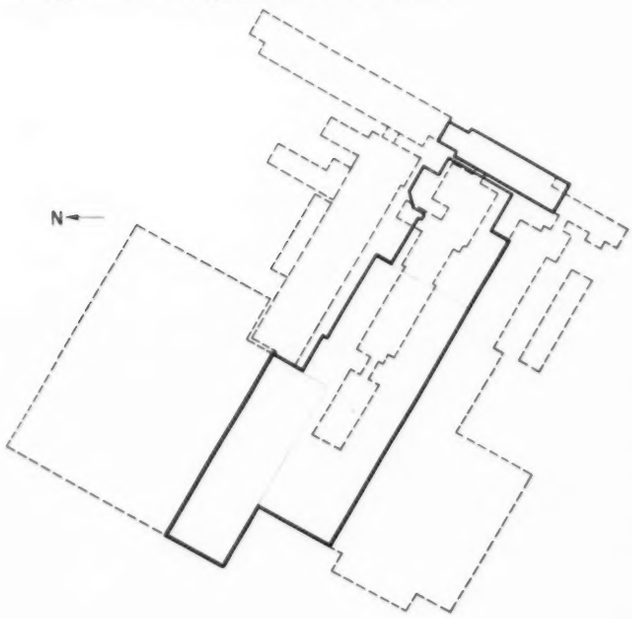
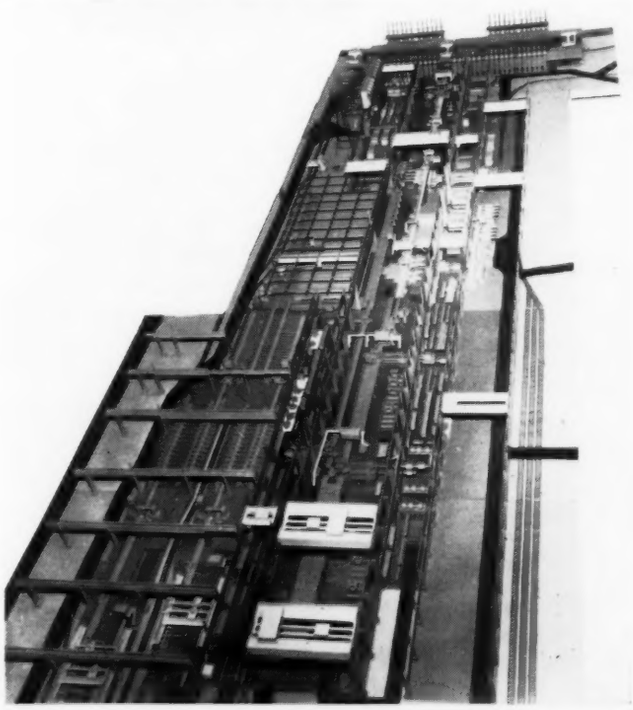


Figure 2 — A scale model was constructed to study access and material flow conditions.



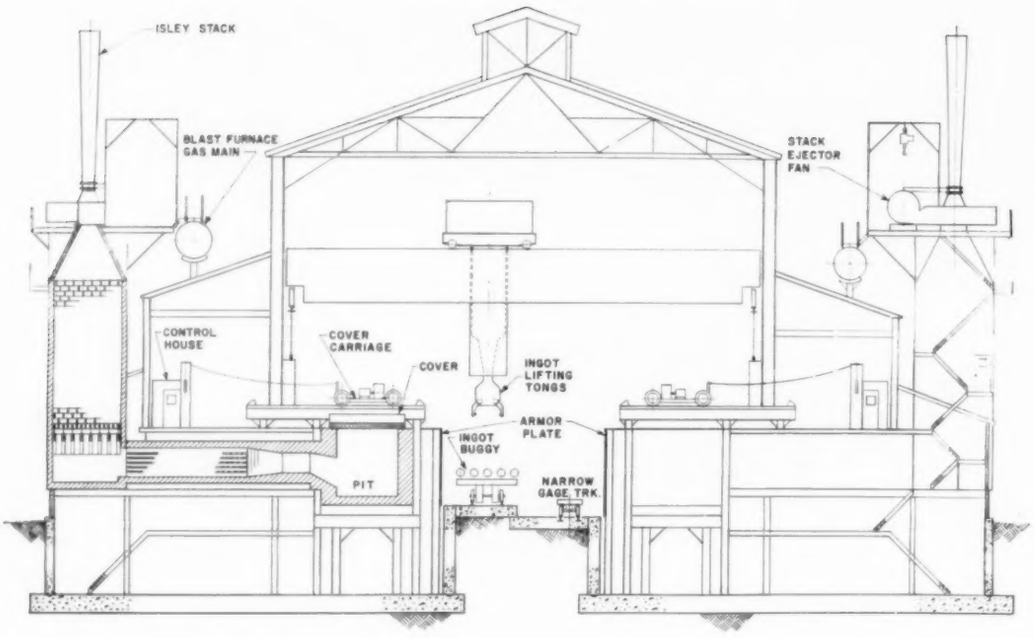


Figure 3 — The 2-level construction scheme provides a large amount of storage space.

to the total area. As indicated in Figure 3, the entire blooming mill and secondary mill units are of bi-level construction which provides a completely free basement area with good ventilation, freedom of movement and extensive storage capacity.

The mill is designed to produce an annual capacity of 1,108,000 tons of primary mill product and 850,000 tons of secondary mill product, including standard structural shapes, light wide-flange sections, sheet piling and semi-finished billets.

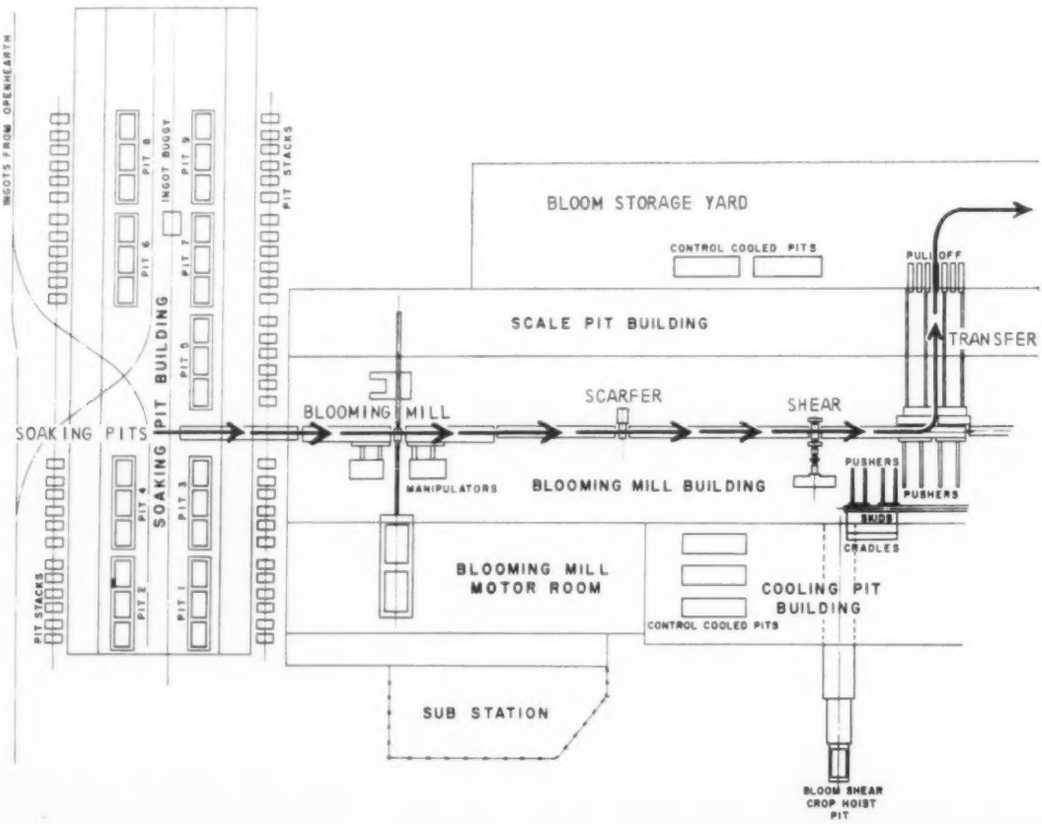
PRIMARY MILL FACILITIES

Figure 4 shows the layout of the primary mill facilities and the flow of product. They include the soaking pits, the 53-in. blooming mill, a hot scarfer, the bloom shear, the sheared product transfer equipment, the billet and bloom storage yard and the scale disposal system.

Soaking pits—The soaking pit installation is unique in many respects. Figure 5, which is a closeup of the model, shows how nine pits, each with three holes, are installed in two groups to provide 4100 sq ft of hearth area in a building only 450 ft in length. This unusual arrangement greatly reduces travel time in transferring ingots from pit to mill.

The design is South Works' own U-fired, and is illus-

Figure 4 — Material flow is in a straight line through the primary mill facilities.



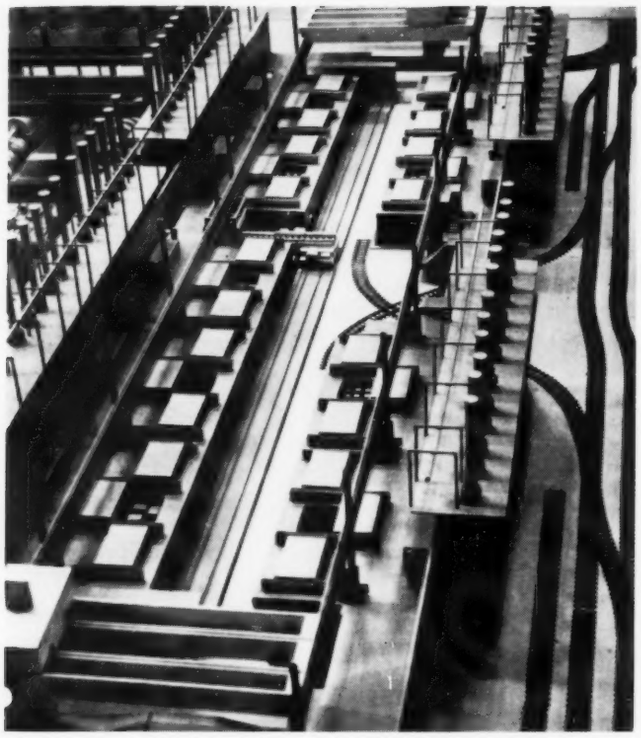
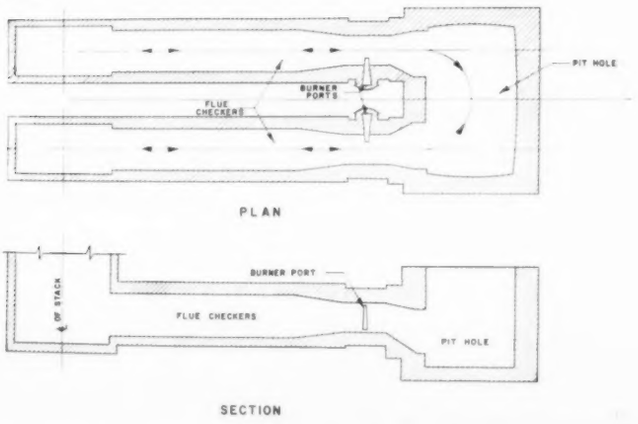


Figure 5 — Ingot handling is simplified by the soaking pit layout.

trated in Figure 6. The flues are on the same side of the pit hole proper and firing is in a horizontal U. This allows completely isolated and metallic-clad flues with no chance of short-circuiting combustion air to the stack. This type flue also maintains a positive draft on the individual pits. Maximum circulation is maintained by change in direction of the gases in the pit proper, and full-off, full-on firing practice. The fuel used is blast furnace gas or a variable mixture of blast furnace gas and natural gas.

The 53-in. blooming mill—The modern competitive market, demanding maximum efficiency of operation in repetitive operations, has dictated the installation of programmed features for this mill. Card-programmed control systems are provided for both the blooming mill and the structural mill. The operator selects the appropriate card punched for a predetermined rolling sequence, inserts it into a card reader, then initiates the complete rolling sequence by pressing a single button. A more detailed explanation of this feature in relation to the particular equipment concerned follows.

Figure 6 — The pits are of the U-fired type and use a mixture of natural and blast furnace gas or pure blast furnace gas.



The 53-in. blooming mill is a high-lift, reversing mill which, in addition to rolling blooms, also is designed to roll slabs up to 52 in. wide. It is driven by individual 6000-hp roll drives and has a maximum delivery speed of 1120 fpm. All table rolls in front and back mill tables within the manipulator and sideguard areas have individual motor drives.

The handling and processing of the ingot are under the control of a central control system. The concept of automatically controlling the processing of hot steel ingots is not new; the positioning of screws automatically on a rolling mill being conceived and installed years ago. It has only been of late that complete automatic control of the handling of the ingot, that is, positioning the screws and sideguards, starting the mill and table rolls, reversing the mill and turning the ingot, all functions occurring without the intervention of an operator, has been successfully applied to a rolling mill. "System engineering," as this concept is now generally referred to, is being applied to many phases of industrial processes today to improve and maintain quality of product, increase production, reduce operator fatigue and minimize abuse to equipment.

The 53-in. blooming mill and the 34-in. structural mill are among the first mills in this country to have the total system concept applied to the original design. Basically, this total system consists of three parts:

1. Position regulating of the screws and sideguards.
2. Position sensing of the product.
3. Sequential control as depicted in Figure 7.

The rolling information obtained from the roll designer and rolling practice is punched into a card; Figure 8 is a sample of a card that has been punched for a $7\frac{3}{8}$ x $32\frac{7}{8}$-in. slab that is to be rolled from a 30 x 40-in. ingot. This information concerns pass number, schedule number, screw-down position, sideguard positioning, entry speed of mill rolls, acceleration rate of mill drive, turns, finger lift and final pass. This data is "read" from the punched card into a memory unit, which consists of a large number of magnetic elements, and is stored there until required in the sequence of operations. Figure 9 shows the sequence checking and magnetic storage section of the card-programmed control unit.

After the ingot is delivered from the mill approach table to the front mill table between the entry sideguards, the operator initiates the rolling operation by pushing a "pass advance" button; this sends the sideguards and the screwdowns to positions according to the punches in the card. As the screwdowns and sideguards move to the command position, a position transmitting device continually monitors the position of the equipment, and when the difference between the reference signal from the card and the signal from the position transmitter is zero, the equipment has reached its command position, or null point. An instant before the null point is reached, called the "start anticipate zone," the table rolls and mill rolls begin to turn at the entry speed, which is also punched into the card. As the ingot enters the rolls, a hot metal detector, called the "roll bite" detector, sees the ingot and calls for mill acceleration

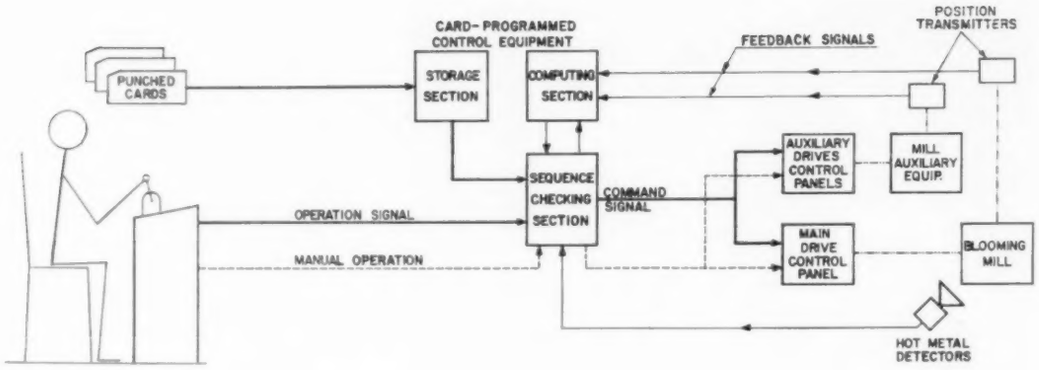


Figure 7 — Punch cards are used to insert the rolling information into the control system.

at the rate which has been punched into the card. Depending on the length of the bloom, the main drive will attempt to go to top speed. A hot metal detector on the entry side of the mill initiates slowdown of the main mill and mill table as the ingot leaves that side of the stand. As the ingot leaves the main rolls, another roll bite detector located on the delivery side of the rolls gives the stop signal to the table rolls and the main drive when the ingot has passed from its range. The ingot will then stop only a few in. from the roll and wait until the screws and sideguards have moved to a new position. This stopping position can be modified by another punch in the card indicating that the ingot is to be turned, and it will stop slightly further from the mill to allow more clearance for turning. This additional distance is determined by another hot metal detector which is located between the mill housing and the leading edge of the sideguard.

At this point, a description of a turning operation is in order, see Figure 10. After the ingot is delivered from the mill, the sideguards position the ingot on the mill tables to provide the proper clearance for turning. The command signal is then given to the left manipulator to move to the left to a new position. When it has moved a preset portion of its total movement, which is programmed, the right manipulator begins to move to its new position and simultaneously the fingers begin to lift the ingot; the stroke of the fingers is programmed by the card and is terminated by the action of a limit switch. When both manipulators have reached their new programmed positions, the screwdowns move to their new position and the tables move the ingot into the mill. When the control has advanced from one pass to the next, the main drive reverses and operates in the opposite direction at the selected entry speed.

Manual intervention can be imposed on any phase of the process and at any time by the operator who is overseeing the operation. The operator may do this by using the miniature master switches conveniently arranged for him on two control consoles, see Figure 11. These switches operate to override data normally furnished by the control card or by the individual control system of the mill function. The master switches have been redesigned for ease of identification. They now have $1\frac{1}{2}$ to 2-in. handles, variously shaped to create an image of the item under control, and are grouped to simulate the mill or product movements. The provision for master control switches is in harmony with the philosophy of system engineering, for operator intervention is reduced to the very minimum, yet manual control is available for intervention should the judgment of the operator deem it necessary.

The scarfing machine—From the blooming mill the bar goes through a retractable scarfing machine which, if used, cleans four sides of the piece in a single pass, and $\frac{1}{32}$ to $\frac{3}{32}$ in. of surface may be removed from the

Figure 8 — Up to ten passes can be controlled from one punch card.

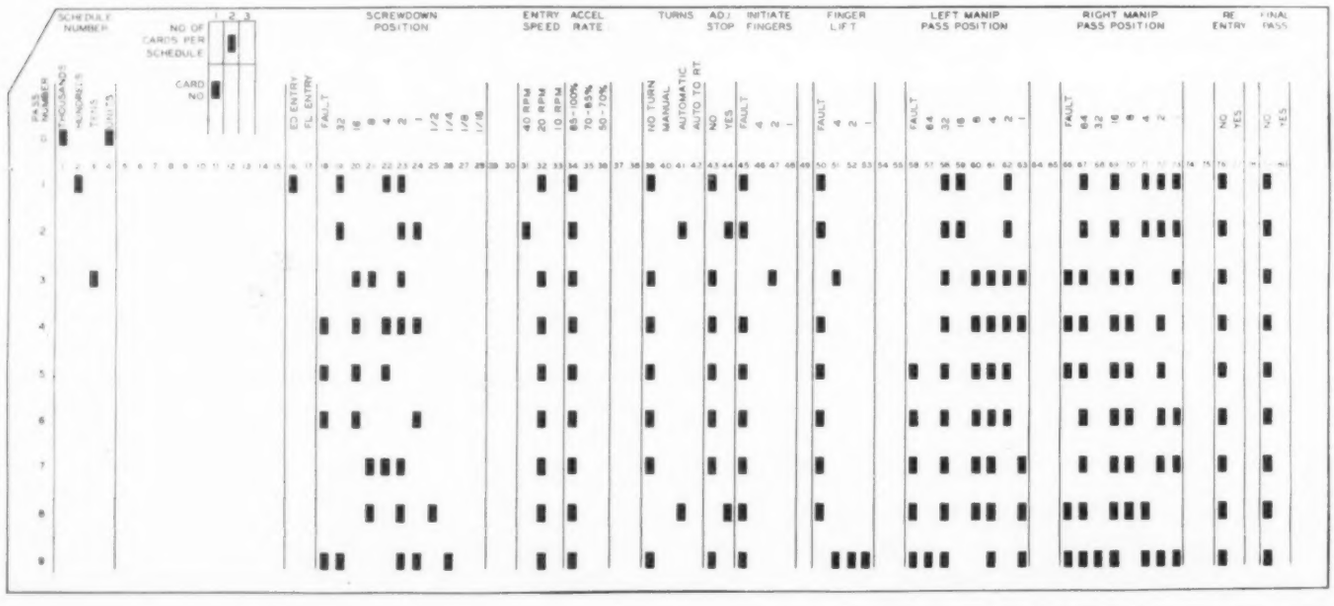


Figure 9 — A magnetic storage unit is required since it is necessary to schedule 29 passes on the 53-in. mill, and the punch cards normally used can only control ten passes.

steel, which is moving at speeds between 60 and 175 fpm. The machine can handle slabs 2½ to 14 in. thick and up to 52 in. wide, or blooms 5 x 6 in. to 14 x 14 in. It has water-cooled burners and is fired with oxygen and natural gas. Smoke is removed by a hood and duct system, an electrostatic precipitator and a suction fan. Slag is removed by 125-psi water in a sluiceway to the scale pit.

The bloom shear—The bloom shear is a down-up-cut motor-operated machine, driven by two 500-hp variable-voltage motors. It can cut 484 sq in. of steel, automatically positioning the bloom and making as many successive cuts of equal length as the operator establishes by means of proper setting of a cut counter. An infrared slow-down detector positions the blooms at the movable gage stop with practically no rebound.

Crop hoist car—The crop hoist is a bucket-type car which positions itself underwater beneath one of two collecting bins by means of a traveling nut limit switch on the cable drum. A 200-hp motor pulls the car up the 205-ft incline and automatically stops it in the tilt position over the narrow gage loading dock where the load is deposited in cars for removal to the open hearths.

Sheared product transfer equipment—The blooms, now cut to ordered length, move from the shear on table rolls to one of four positions determined by disappearing stops between the table rolls. The blooms are then stamped and transferred from the table rolls by a pusher onto a depressing platform, used when vertical stacking may be required. The operator lowers the platform and then pushes the blooms off the table.

From the piler, blooms are pulled by a rope-driven transfer car into the storage yard. There, overhead cranes lift the load on C hooks for placement on pallets. The loaded pallets are moved by straddle carrier to locations in the bloom storage yard where they are stacked.

Billet and bloom storage yard—The billet and bloom storage yard will serve as a storage and classification area to set up secondary-mill rollings, and as a processing and storage area for primary-mill semi-finished products. It is anticipated that all structural product scheduled for the 34-in. structural mill will be rolled from a cold charge; therefore, this storage yard will provide vital service to both mills. Equipment in this area includes billet dock cranes, straddle carriers, two con-

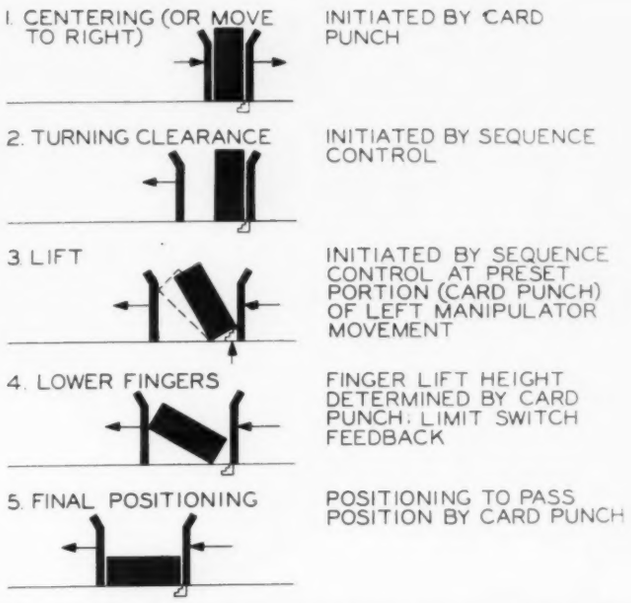

1. CENTERING (OR MOVE TO RIGHT)
INITIATED BY CARD PUNCH
2. TURNING CLEARANCE
INITIATED BY SEQUENCE CONTROL
3. LIFT
INITIATED BY SEQUENCE CONTROL AT PRESET PORTION (CARD PUNCH) OF LEFT MANIPULATOR MOVEMENT
4. LOWER FINGERS
FINGER LIFT HEIGHT DETERMINED BY CARD PUNCH; LIMIT SWITCH FEEDBACK
5. FINAL POSITIONING
POSITIONING TO PASS POSITION BY CARD PUNCH

Figure 10 — The programmed sequence action of the manipulator and fingers is illustrated.

trolled cooling pits and billet piling and furnace charging mechanisms.

Scale disposal system—During the sequence of operations from the time the ingot leaves the soaking pit and progresses to the shear, a certain amount of scale is removed from the heated steel. The scale is handled in shaker conveyors located under the ingot buggy discharge station, the mill tables and the main mill proper. Figure 12 illustrates this arrangement. About 350 ft of 36-in. conveyor is arranged in five sections, each powered by a 20-hp motor. The conveyor operates on a time cycle, a usual cycle being three min on and five min off. It can handle 35 tons of scale per hr.

A large volume of water which is sprayed on the rolls for cooling is picked up in the conveyor under the mill. The conveyor can handle as much as 650 gpm. Combined water, scrap and scale are moved into scale pits having grizzly bar deflectors which cause heavy scrap to fall into one pit and lighter material into a second pit. Water from both pits is reconditioned as necessary and run into the plant sewage system. The residue in the pits is removed by clam-shell buckets and trucked to recovery stations.

Figure 11 — Manual override is provided to permit the operator to control any action of the rolling sequence should it be necessary.

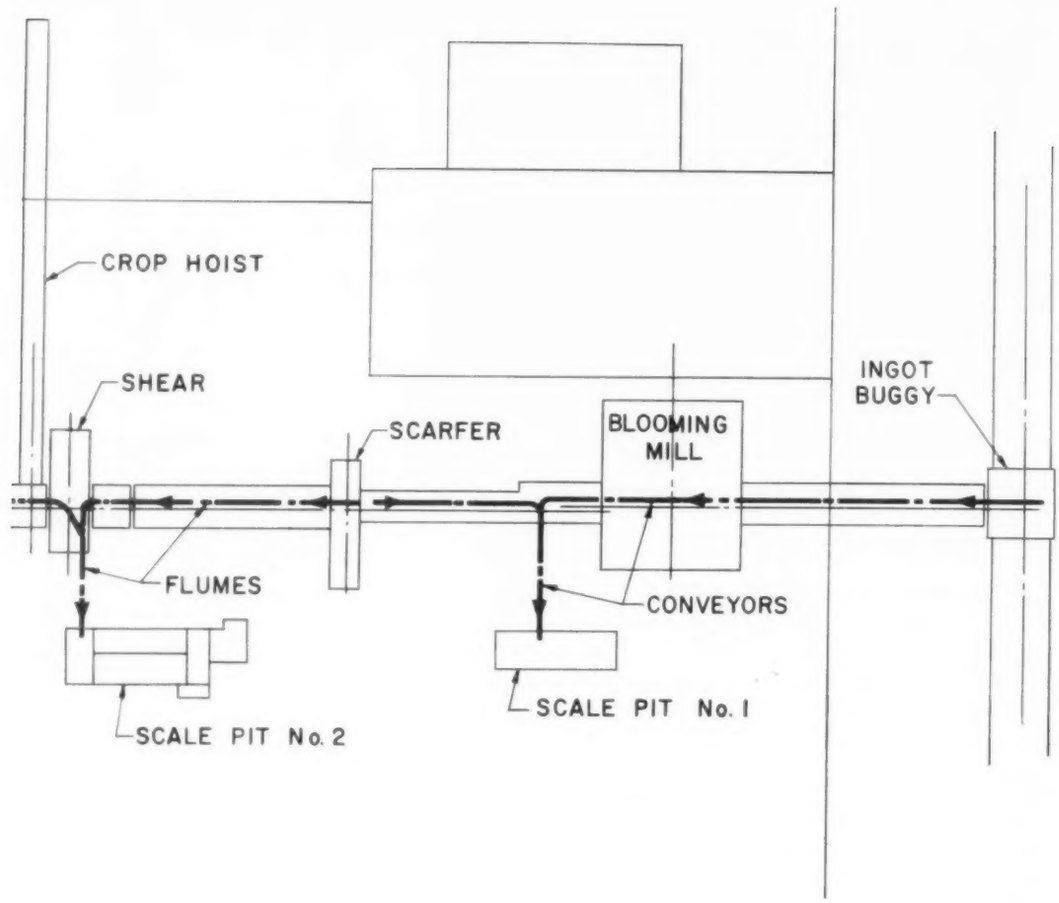


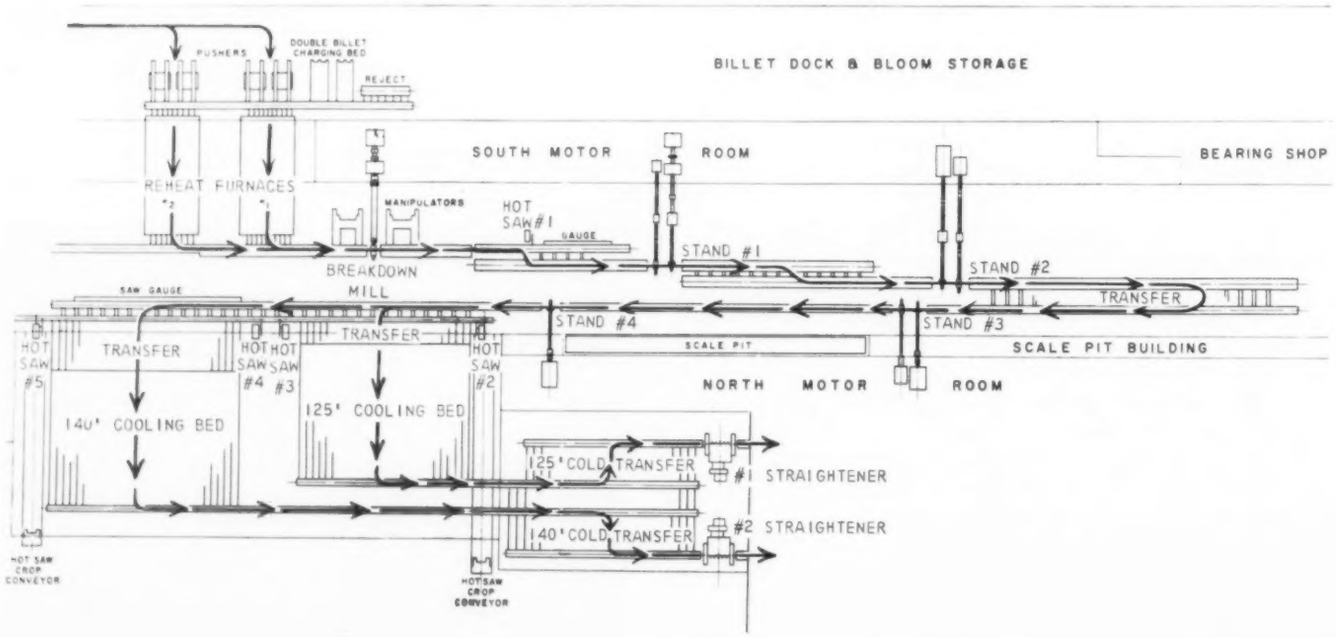
Figure 12 — Mill scale is diverted into one of two scale pits and is then removed for recovery.

SECONDARY MILL FACILITIES

Figure 13 indicates the layout of the secondary mill facilities including the flow of product. These facilities consist of two reheating furnaces; a 40-in., 2-high reversing mill; product transfer equipment; and a 34-in. structural mill proper, including four roll stands, four hot saws for parting and cropping product, two cooling beds, two cold transfers and two roller straighteners.

The reheating furnaces—Returning to the bloom storage area, the last mentioned location of the steel, the bloom is lifted by crane to an unscrambler table where it is inspected, then run on table rolls from which it is pushed into either of two reheat furnaces. These furnaces, fired by natural gas with oil stand-by, have hearths 40 ft wide and 81 ft-3 in. long. They are continuous-type furnaces with a unique 5-zone arrangement.

Figure 13 — Layout of 34-in. secondary mill facilities.



The cold blooms are pushed laterally into the furnace. The entire furnace load is moved during each push and a heated bloom is dropped out on the delivery side. Water-cooled skids support the blooms in the furnace. Closed-circuit television is used to monitor the delivery side of the furnace so that regardless of the bloom dimensions on the entry side, the furnace load will be moved only enough to deliver a single bloom. The furnace doors, table rolls and pusher drive have interlocks to make the operation as foolproof as possible.

The structural mill—The structural mill is a semi-continuous type, consisting of a breakdown mill and four structural stands. Product is handled in a manner similar to that at the blooming mill. The steel is moved by table rolls, slowed down and stopped by hot metal detectors, pushed across the table rolls by movable sideguards and turned by fingers on the sideguards.

The breakdown mill is a 40-in. reversing mill with a 90-in. roll face, individual motor drives of 4000 hp on each roll and two 150-hp motors for driving the screwdowns. The positioning accuracy over the 30-in. roll-opening range is 0.1 in.

The parting saw—From the breakdown mill, the partially-shaped bar is delivered to a 800-hp, belt-driven parting hot saw, where it is cut in two. This is necessary on certain shaped blooms or beam blanks which otherwise would exceed length limitations.

Product transfer equipment—The transfer cars, mounted between alternate table rolls in a slot in the table apron plates, are coupled together by a shaft the length of the mill table. The table rolls are on 5-ft centers. The longest transfer is 305 ft long. When the steel moves on the table rolls, the transfer cars are recessed in the slots. To carry the steel on the transfer cars, hydraulic cylinders raise the cars about two in. to lift the product off the table rolls, and electric motors at the ends of the shaft joining the cars drive them to the new position. It should be mentioned that the hydraulic lifts on the transfers were used so as to minimize any surface marking of the product in moving from one pass or mill to another. The transfers carry the product broadside from stand to stand and between passes.

Figure 14 depicts the procedure for the rolling of a standard structural section in stand 1, and transferring of the product to stand 2. Hot metal detectors located adjacent to the entry and delivery sides of the mill stands and under the mill tables are the sensing elements employed to indicate the location of the bar and to initiate mill and table acceleration, slowdown and stopping. When the "stop" signal has been received by the sequencing control, the transfers are automatically raised, moved to a programmed position, lowered and the bar is returned to a different roll opening. Normally, three such passes occur for stands 1 and 2; however, stands 3 and 4 are nonreversing, and after the product is transferred to stand 3, it passes consecutively through stands 3 and 4 to the hot saw area.

Double rolling of standard structural products with this design and layout is possible and takes advantage of the facts that the main rolls have three grooves, each for the successive passes that the bar makes through the stand, and that ordinarily the rolls are not raised or lowered. Consequently, there can be bars in pass 1 and pass 3 simultaneously, which increases the rolling rate.

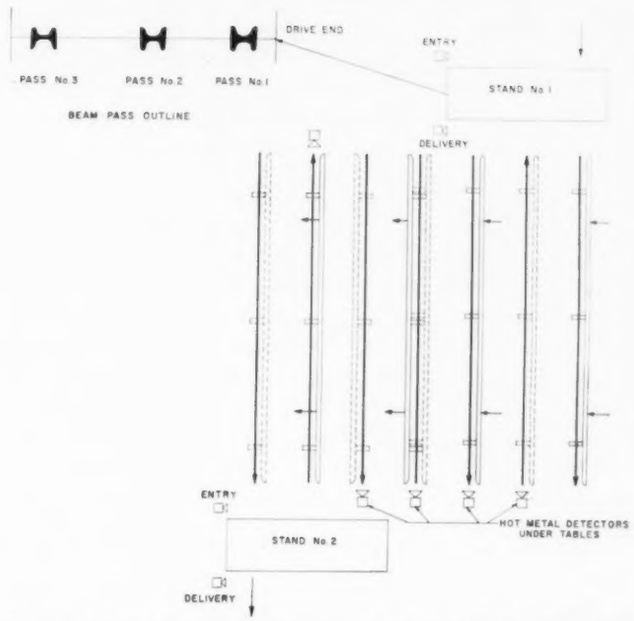
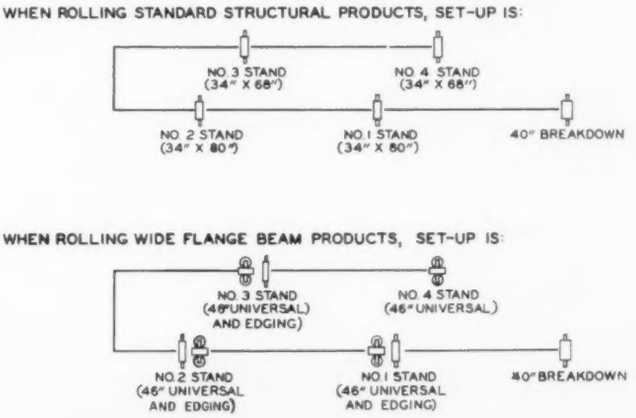


Figure 14 — Hot metal detectors are used to sense the presence of the bar and to initiate transfer actions.

The 34-in. structural mill—As indicated in Figure 15, the structural mill proper is arranged in a double-line hairpin with two stands in each line. The first and second stands are the reversing type, and the last two are single-pass, uni-directional stands. When rolling wide-flange sections, stands 1, 2 and 3 consist of a universal and edging combination, and stand 4, the finisher, is a single universal stand. When rolling other structural sections, the universals are replaced with 2-high horizontal roll stands, and the edgers are replaced with movable table sections. Each stand will be a complete unit arranged for clamping to the shoes and fitted for rapid coupling or uncoupling of oil lines and drives.

The first roughing stand of this structural mill is equipped with twin-motor individual roll drives, but is also provided with a pinion stand which can be used for positively tying both rolls together, or in which shafts can be used to drive the rolls separately. This unique installation is provided with a 4000-hp drive on each roll. The remainder of the mill stands are powered with single motors and pinions. The second stand has a 6000-hp motor; the third, a 4000-hp motor and the fourth, a 3000-hp motor. All edgers are driven

Figure 15 — The use of two mill setups permits the rolling of a diversified group of structural sections.


WHEN ROLLING STANDARD STRUCTURAL PRODUCTS, SET-UP IS:
NO. 3 STAND (34" X 68")
NO. 4 STAND (34" X 68")
NO. 2 STAND (34" X 80")
NO. 1 STAND (34" X 80")
40" BREAKDOWN
WHEN ROLLING WIDE FLANGE BEAM PRODUCTS, SET-UP IS:
NO. 3 STAND (46" UNIVERSAL AND EDGING)
NO. 4 STAND (46" UNIVERSAL)
NO. 2 STAND (46" UNIVERSAL AND EDGING)
NO. 1 STAND (46" UNIVERSAL AND EDGING)
40" BREAKDOWN

by a 1500-hp motor through a pinion stand. The screw-down setting accuracy of the last stand is 0.001 in.

All the table rolls from the parting saw and throughout the mill to the finishing end are driven by individual table roll motors. The mill table rolls use mill-type motors size 7½ to 15 hp and are powered through variable-voltage systems. The motors are arranged for direct drive. There are almost 500 individually-driven table rolls and most have been designed for easy removal as a unit for repair and maintenance.

Basically, the card-programmed control for the 34-in. structural mill contains the three elements that were required in the blooming mill; that is, position regulators, position sensing devices and sequence control and checking components. One difference to be noted between the two systems is that the blooming mill control stores the card-punched information in a magnetic memory unit and draws upon this information as required, while the structural mill control receives the information directly from the punch card.

Noteworthy advancements in the rolling of shaped products have been made in the design of this automated structural mill. Such features include 180-degree manipulation of shaped bars, automatic re-entry of the bar into the mill to prevent split ends and multiple-stand integrated automation.

The 34-in. structural mill control on the 40-in. breakdown stand and stand 1, which have individual drives on each roll, also features speed-ratio control between the top and bottom rolls. This feature, together with multiple speed points, helps to control turn-up and turn-down of the bar being delivered from the mill stand and provides the roll designer greater latitude in the design of the rolls. In addition, draft compensation control, or speed matching, permits very critical speed regulation between the main mill and edger stand at stands 1 and 2 to compensate for variations in draft and roll diameter when this combination is used in tandem for rolling wide-flange products.

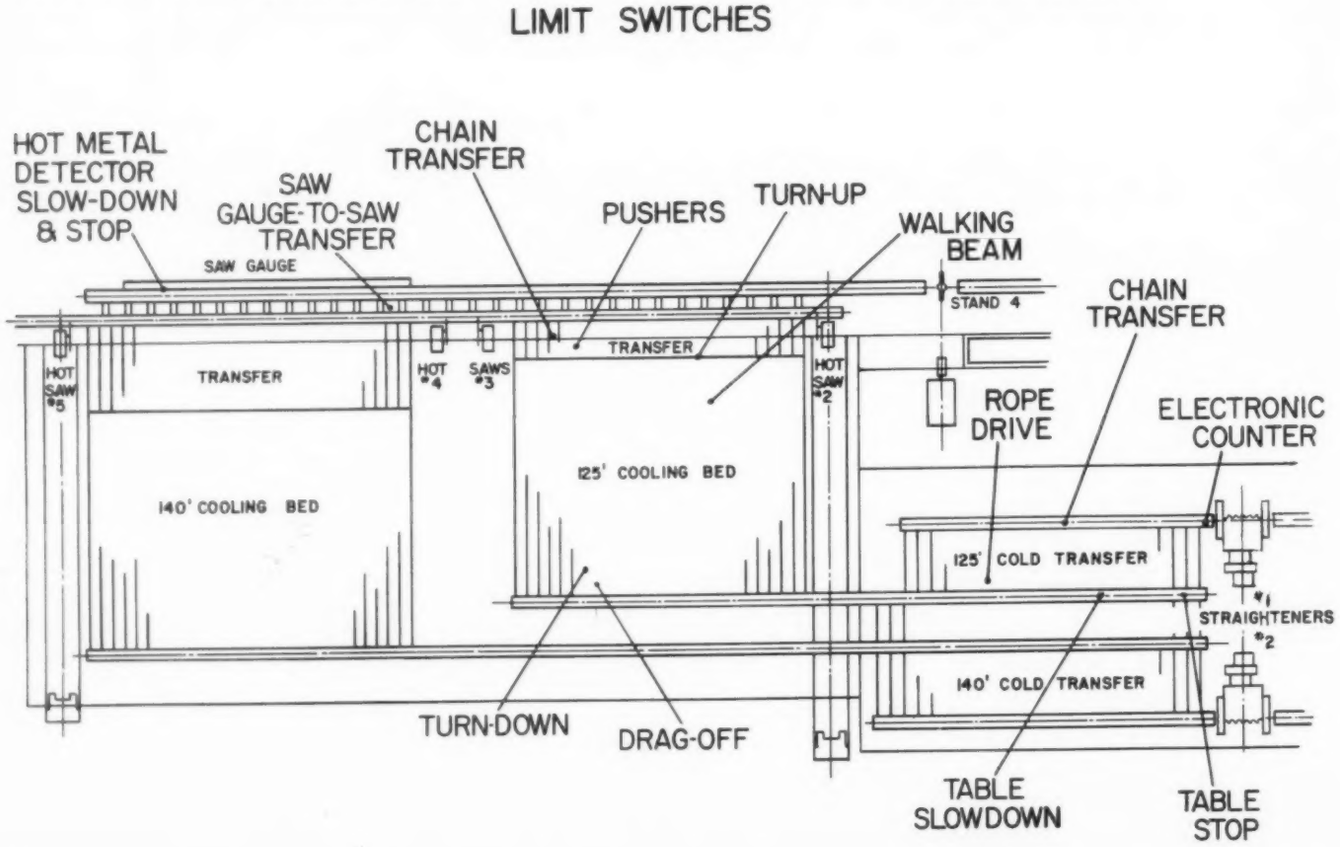
The particular construction of this mill offers many advantages for the roll designer. The advantage most appreciated is that bars enter all passes in a horizontal plane rather than having to run uphill into the rolls. This action allows flanges to lengthen rather than pull down; consequently, beams and channels are easier to produce. Greater pass spread, however, must be provided for angles and zee bars. Another advantage concerns the guide lengths, which are longer, thus enabling the operator to deliver unbalanced sections, such as unequal leg angles and centersill zees, from all passes without end hook or sweep.

However, one factor which the designer must consider is that the three passes in stand 1 and in stand 2 must be designed very close to the ideal in order to roll all foot weights without resorting to programming of screw movements. Further consideration must also be given to variation of mill spring from pass to pass which can only be adjusted once for the three passes.

To date, trial rollings of 42 different sections have been completed and only four of these have caused any difficulty due to roll or pass design. These few problems are being resolved.

Operating experience with this mill has spotlighted areas where modifications to the original design by field engineering forces were necessary to improve equipment reliability. One such example was the location of

Figure 16 — The cooling beds operate as an automatic system after the cycle is started by the operator.



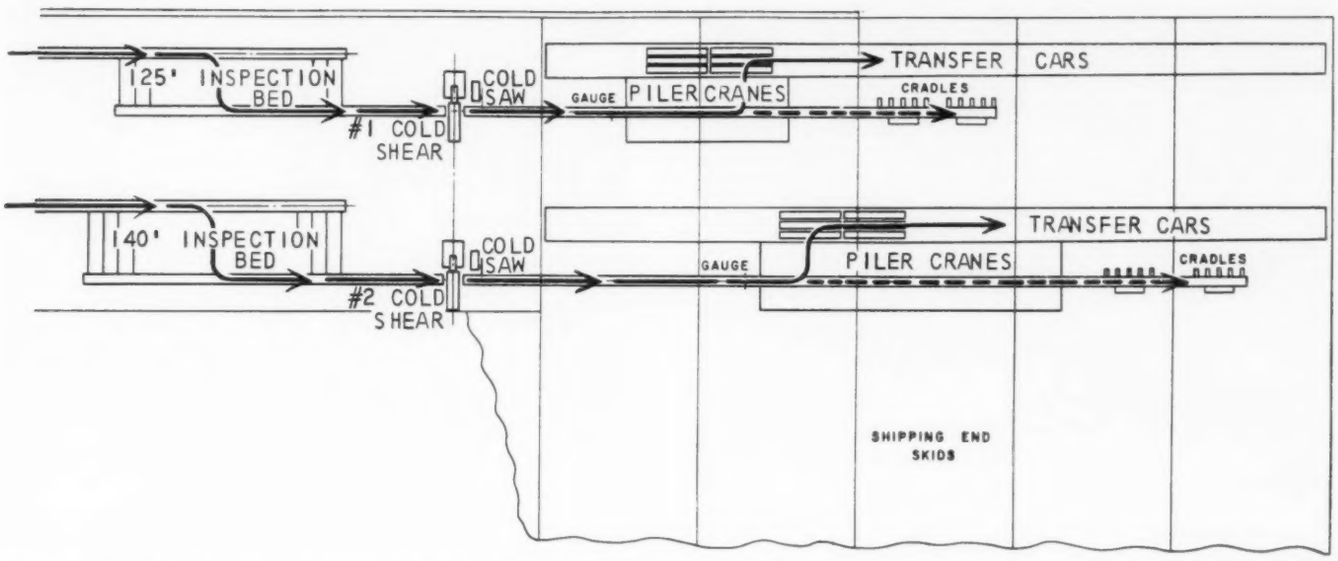


Figure 17 — Parallel inspection and finishing facilities increase the utilization of the mill.

the multiple position transmitter feed-back units which were geared to the screws in the mill housing. Because of the oil, grease, water and the somewhat vulnerable location, it was decided to put these units in the motor room adjacent to the sequence control panels and power them with more rugged position transmitter replacements. This has proved to be a very effective move.

Hot saws—As the finished bar leaves stand 4 and is delivered onto the saw gage table, hot metal detectors initiate slowdown and stop the bar against the gage stop. The stop signal from the hot metal detector causes the transfer car to raise the bar off the table rolls and transfer and lower the bar in front of hot saws 3 and 4. The travel of the transfer is determined by a limit switch which stops the transfer and lowers it. The saw clamp is next operated manually, as is the saw which parts the bar in two pieces. After the bar is parted, each section is moved in opposite directions manually on the saw tables and positioned in preparation for transferring to the cooling bed; the tail-end section is first moved to hot saw 2, so that the end can be cropped. The clamping and sawing actions here are presently being manually controlled.

Cooling beds—From the saws the product is moved to one of the two cooling beds. The length of each cooling bed is 100 ft, one bed being wide enough to handle 125-ft length of product, while the other is designed to handle a 140-ft length.

Figure 16 illustrates the features of the equipment which permits automatic control. It works this way: upon the positioning of the bars in front of the cooling bed, the operator pushes a "cycle" button, causing transfer chains to automatically raise the bar and advance it to a position where a set of limit switches stop the chains and initiate the pushers which move the bar onto the cooling bed walking beams. Another limit switch now restricts the stroke of the pushers, causing them to retract. In addition, the turn-up mechanism is initiated to turn the bar 90 degrees, if required, and to advance the entire cooling bed walking beam assembly one space forward; the stroke of the walking beam is adjusted by the operator, depending on the size of the structural piece.

At the delivery end of the cooling bed, the turn-down mechanism turns the bar 90 degrees after it has been walked across the cooling bed. Next, the drag-off mechanism pulls the bar onto the cooling bed runout table, and the tables automatically start to deliver the product into the cold transfer area.

Cold transfers—This equipment is a combination lifting chain and rope transfer type, with ropes and chains spaced at 6-ft centers. On the cold transfer runin tables, the bar engages slowdown and stop limit switches which stop the table drives as it approaches the end of the tables. Automatically, the bar is pulled laterally onto the cold transfer bed by the cold transfer rope drive until it is caused to stop by an electronic counter which brings the piece to a point on the chains a selected distance from the previous piece. The electronic counter makes this possible by subtracting the proper distance from the rope drive travel for each piece deposited on the chains, and by adding this same distance to the travel of the rope drive each time a piece is advanced by the chain drive and deposited on the cold transfer runout table.

The cold transfer runout tables are started when the inspection bed pushers complete their return stroke. This introduces the bar into the straightener, which runs continuously.

Straighteners—The two straighteners are the overhung type, having four bottom and five top rolls which are driven by a 375-hp motor. The straighteners can handle shapes with a maximum section modulus of 15 $in.^3$ and have speeds of 300 to 800 fpm.

FINISHING AND HANDLING FACILITIES

Figure 17 illustrates the layout of the finishing and handling facilities and the flow of product. These facilities include, in each of the two parallel processing lines, inspection beds, universal cold shears, friction cold saws, piling cranes, transfer cars, billet push-offs and cradles.

Inspection beds—The straightened bar emerges from the straightener onto the inspection bed runin tables, which run simultaneously with the straightener. At the

Figure 18 — If necessary the sections are rotated by a turning device.

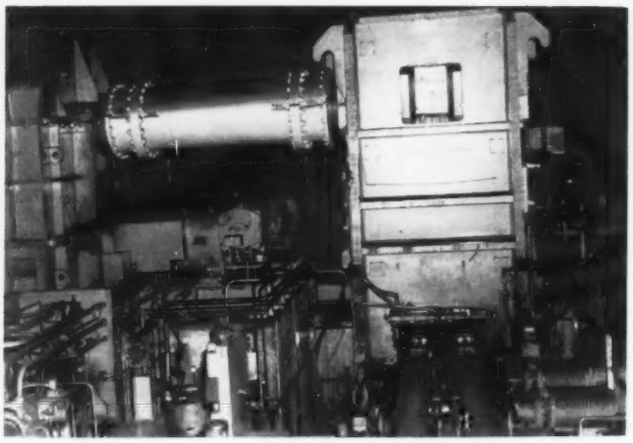


Figure 19 — The cold shear can make multiple product cuts depending upon the section size.

end of the runin tables, the bar engages the slowdown and final stop limit switches. Automatically, the pushers move the bar laterally onto the continuously moving inspection bed chains. These chains then deliver the bar to a set of stationary skids on the opposite end of the inspection bed or, if used, to the turning device, which is located in the middle of the bed, see Figure 18. This turning device is a wheel with notches at 90-degree spacings around the periphery. When the turning device is in the raised position, the bar trips a limit switch as it enters the notch; this initiates the movement of the wheel. The turning device rotates, depositing the bar in the turned position on the moving inspection bed chains. The product then moves to the stationary skids. Here, another limit switch is engaged which causes the shifters to push the bar laterally onto the inspection bed runout tables. Upon completion of the lateral shift, the bar automatically advances toward the shear.

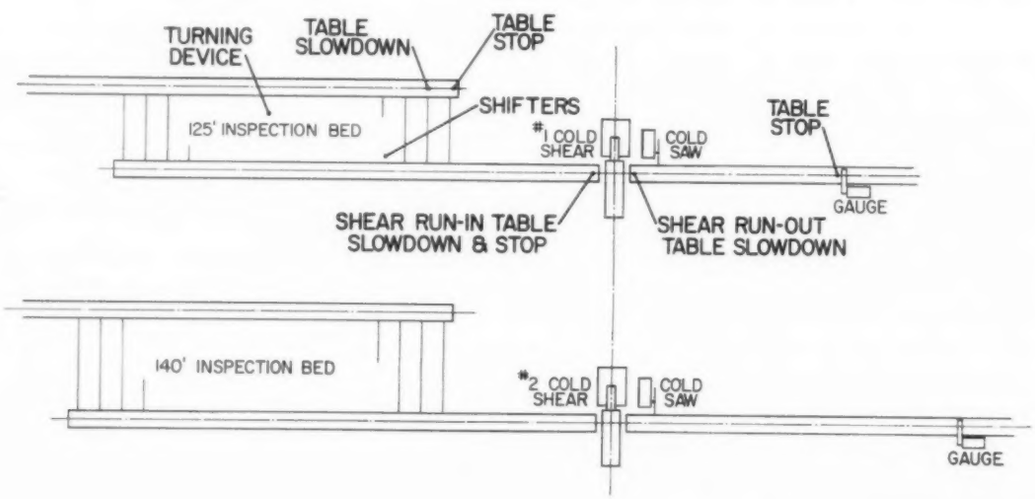
Universal shears and cold saws—These shears, capable of cutting most sections rolled, are used to cut product to the ordered length. Product which cannot be cut by the shears is cut to length by electrically-driven 60-in. friction cold saws mounted adjacent to the shears. The shear is driven by two 275-hp motors and can make 16 strokes per min. It can cut three angles having foot weights up to 20 lb per ft; two channels or beams up to 10 in. and two angles up to 26 lb per ft; and it takes cuts on single product pieces up to 18 in. Figure 19 illustrates the simultaneous cutting of two beams.

Automatic control features of the cold shear equipment are illustrated in Figure 20. A limit switch located immediately in front of the shear, when engaged by the bar, slows down and stops the bar against a disappearing stop on the delivery side of the shear for a front end crop. The operator then initiates the first shear cut manually. After the cropped end drops onto a scrap conveyor, the shear runin and runout tables start automatically and the bar advances toward the shear gage. This gage is moved into position by the shear operator and is positioned by a selsyn-driven position regulator. As the front end of the bar leaves the shear, it trips a limit switch which starts a slowdown integrator, and the bar stops against the gage when it hits a chain-curtain limit switch; the gage stop raises automatically and the shear cut-cycle begins. After the cut-cycle has been completed, the shear runout tables start automatically and remove the cut section of bar. After a time interval, the shear runin tables start automatically and bring ahead the remaining bar to be cut into preset lengths.

Scrap removal from the shear and saw is handled through a vibrating conveyor to a bucket, which is later removed by an overhead crane.

Piling beds—After the bar has been cut at the shear or saw, it progresses to the piling bed. Piler automatic sequencing is illustrated in Figure 21. Again, a limit switch stops the bar against one of three disappearing stops which has been selected by the piling bed opera-

Figure 20 — The cold shear and associated equipment operate automatically once the gage length has been set and the first cut initiated.



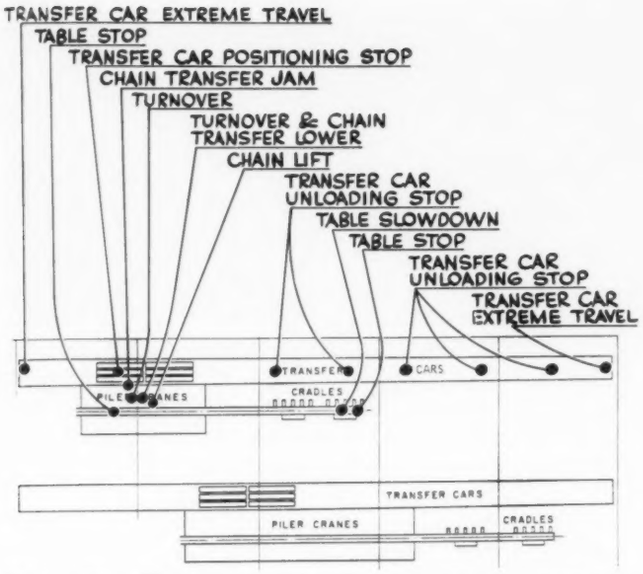


Figure 21 — The locations of the limit switches necessary to automate the piling beds and transfer equipment are illustrated.

tor. This also automatically raises the continuously-moving piling bed transfer chains, and the product is moved toward the turnovers. If it is to be turned, the operator can preset the sequence; that is, so as to turn every bar or every other bar. The bar engages a limit switch which initiates the turnovers; this also lowers the chain transfer so that it is ready to receive the next bar from the shear. After the turning of the bar, it continues on the moving transfer chains to the end of the piling bed where it engages a mechanical stop.

Piler cranes—The next step of moving the sheared product involves piler cranes. These cranes are manually controlled by an operator in a floor-mounted pulpit; as many as four cranes can be operated in synchronism through servomechanisms, with a tolerance of $\pm 1/4$ in.

As these cranes must normally handle all mill product, it is interesting to note the following:

The highest output scheduled off the mill is in the lighter foot weights. A 250-ft piece can be put on the cooling beds every 19 sec. Cut in half, this puts a bar down both finishing end production paths through the transfers, straighteners and inspection beds every 19 sec. Triple cut to the minimum length of 10 ft puts a load of roughly 38 pieces per min on each piler. Because of these expected high handling rates, the cranes have been equipped with vacuum lifts rather than magnets for fastest possible pickup and dropoff of the load. Figure 22 provides a view of these vacuum cups.

Transfer cars—The cranes lift the bar (or bars) and set it on a transfer train, which is then dispatched by an operator to a preselected unloading bay where it is stopped by a limit switch. The car is then unloaded by an overhead crane with chains and returned by the operator to the loading position, where it is stopped by another limit switch. Each transfer train, comprised of three cars to a train, is rope driven by a 100-hp motor and has a speed of 370 fpm.

STRUCTURAL FINISHING DEPARTMENT

All the described equipment in the structural finishing dept. is housed in 11 bays, under one roof. Each bay is serviced by a minimum of two overhead electric traveling cranes for the handling of material.

Straddle carriers are utilized for handling and storage of slow moving stock such as barge loads, for handling such supplies as blocking lumber and occasionally for transfer of material from bay to bay.

Transfer between bays is primarily accomplished through use of a continuous roller transfer line serving all bays, or by means of a captive 25-ton diesel locomotive and flat cars at the primary loading tracks.

Loading can be done in any of the 11 bays on standard gage railroad cars or trucks. Loads may consist of product from either mill, or product from both mills.

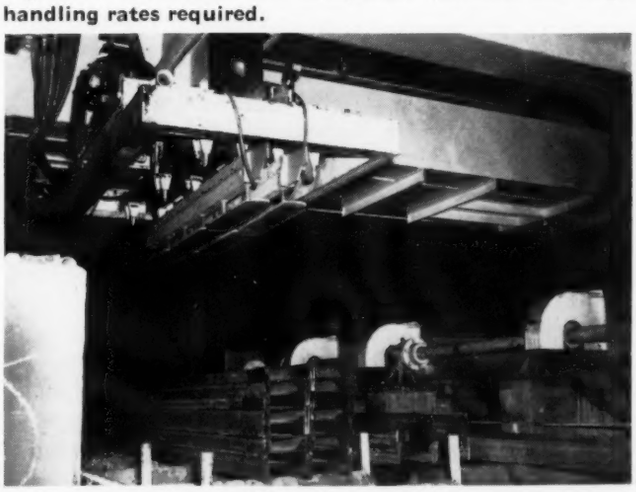
Figure 23 indicates the types of structural shapes which the finishing dept. handles. They include various sizes of channels, special channels, standard beams, H-beams, wide-flange beams, angles, special angles, zee bars and piling bars.

REPAIR AND MAINTENANCE

Great stress on maintenance is essential to obtain optimum results from an automated mill. For example, break-away motor currents and normal running friction loads must be kept stable and within the ratings of the drive motors and generators or accurate positioning of the equipment by the position regulators and feed-back units cannot be accomplished. The luxury of a long break-in period for this new equipment could not be tolerated; practically normal operating loads were present when the unit was put into operation for its first run. Sound maintenance techniques, it was apparent, were the first order of business.

Interesting aspects of the approach to maintenance include the following: Periodic maintenance checks are made with recording instruments to determine whether all units are functioning properly. Deviations from recorded history are noted and analyzed, and when the cause becomes apparent, corrective action is taken. The particular action taken to correct a malfunction is recorded in a log book, which is maintained by each control center. This information is studied by maintenance personnel, in conjunction with the control supplier and design engineer, and has proved very useful in determining causes for control component failure, and also in deciding the final material or circuit changes necessary to overcome the failure.

Figure 22 — Vacuum lift equipment permits the high handling rates required.



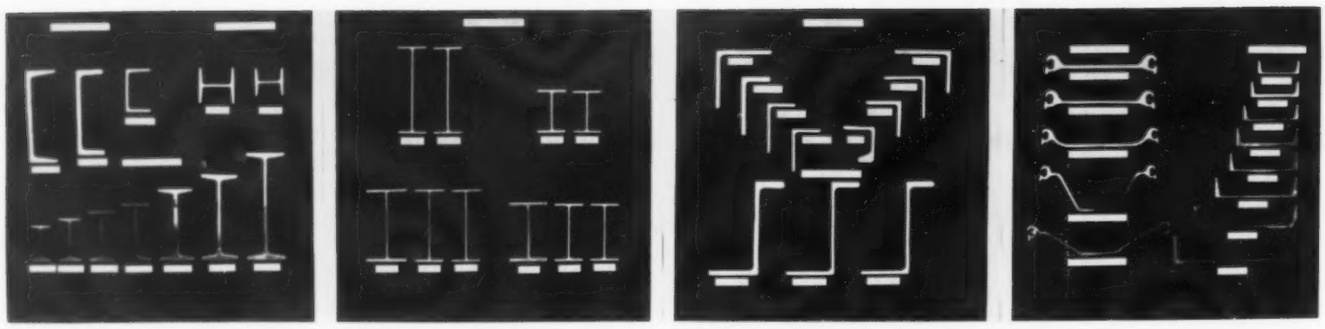


Figure 23 — The product diversification is quite broad and includes a number of special sections.

Personnel selected for maintenance of the automatic controls are required to attend a comprehensive training course concerning repair of electrical equipment.

Maintenance supervisors were divorced from all operating responsibilities and assigned to work cooperatively with the control supplier and the design and field engineer. Through this approach, these men have become quite proficient in their ability to maintain the automated controls of the mills.

SUMMARY

It will be noted that an attempt has been made to minimize the human effort required for direct operation of the manufacturing process. Insofar as possible, programming and sequencing have taken over the shaping of steel.

That more attention must be given to planning, providing and maintenance is generally accepted as part of the cost of process simplification. However, the advantages can be stated this way:

1. Ease of operation.
2. Improvement in product quality.
3. Higher sustained output capability.
4. Decrease in abuse of equipment.

Discussion

PRESENTED BY

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E. C. Peterson: The cooling beds on this mill advance step by step as pieces are fed to them, thus maintaining individual spacing as opposed to conventional structural beds. In this way, the warpage of symmetrical sections can be substantially reduced, and the manual labor incident to breaking open packs of shapes on the bed is eliminated. Furthermore, since the bed is progressively cooling hot material at all times over its entire area, it has twice the efficiency of a conventional bed where shapes are packed over an entire section and allowed to cool completely all together.

However, with a step-by-step progression of the bed, it is important that some surge capacity be provided. Otherwise, the operations of straightening, inspecting, shearing and piling which follow the bed will be tied rigidly to the mill operation, and a delay in the finishing end will immediately cause the shutdown of the mill. This factor is often overlooked, with unfortunate results.

However, in the present installation, a very flexible surge bed has been provided in the cold transfers. Here, there is provision for a floating supply of shapes which can be added to at one end by a cable and dog transfer as shapes are delivered from the bed. Entirely independently of this activity, a lift chain transfer can advance the reservoir of shapes to the straightener entry table. In this way, the finishing end and the mill can operate independently for a considerable length of time, until either the reservoir's supply of shapes or its storage capacity have been exhausted.

Allan T. Ricketts: Is the programming of the mill continued into the cold cutting, and if so, is there any difficulty in synchronizing the cold cutting with the rolling sequence?

V. H. Lindberg: The 40-in. mill and the 34-in. structural mill are programmed down to the hot bed area. Sequential automation takes over at the hot bed area and is continued through the straighteners, shears and pilers. On larger sections such as piling bar, centersills, zees, etc., which are normally cold sawed, bottlenecks have been experienced due to delays in the cold saw areas. In some cases, double length-order bars are cut to keep up with the pace of the mill, and then material is brought back into the shear line during roll changes or other downturns on the mill. The step sequencing from the hot beds down to the pilers has still to be optimized for further improvements.

At the present time this area is being controlled manually, until control and limit switch circuiting is completed.

D. J. Fapiano: During the early engineering phase of this project, considerable controversy surrounded the choice between twin and pinion stand drives for the

breakdown mill and stand No. 1. U. S. Steel's ultimate decision to proceed with twin drives, although based on extensive study by them and by one of the electrical companies, was nevertheless a revolutionary break with past practices in the rolling of unsymmetrical shapes.

Although the complete range of products has not yet been rolled and considerable evaluation remains, mill performance to date seems to substantiate earlier analysis.

Several preliminary observations concerning the relationships between torque, speed and bloom curvature may be of general interest. For certain shapes it has been noted that speed differences as high as 18 per cent of the faster roll speed have been required to deliver a straight bar. Under this condition the load was all on the faster roll, with the slower roll at zero load or even slightly regenerative.

Early attempts to relate transient performance to bar curvature assumed that the integrated speed error between top and bottom rolls would appear as curvature. This assumption is, in many cases, extremely pessimistic, producing calculated curvatures far exceeding those observed. In fact the curvature that could be produced by speed differences introduced for test purposes was sometimes limited by the difference in forces which could be sustained at the bar surfaces without roll slippage.

It must be concluded that, with appropriate control, twin drives may be successfully applied to mills rolling shaped, as well as flat, product. There is already evidence that such a system may permit successful rolling under conditions unsuitable to mills employing geared work rolls.

V. H. Lindberg: The use of twin drives on the 40-in. mill has been beneficial on a number of unbalanced structural sections; however, there have also been detrimental effects on balanced sections due to the scale on bars, bar temperature and roll slippage. The mill is now being operated using speed-ratio control on unbalanced sections and load balance on regular balanced sections. The research people have recently completed an experiment covering the rolling of a number of blooms using different drafting patterns, temperature variation of bars and scaling condition. A report on this project should be available in the near future.

When changing a rectangular bar into an unequal shape, the very nature of the operation requires unequal loading of each roll, with one roll at times requiring maximum motor capacity with the other motor at zero load or even regenerative.

The unequal loading is satisfactory except when something occurs to unbalance the system, such as cold spots, scale or unequal section, as encountered in reentry of a bar. This usually results in the heavily loaded roll slipping on the product and causes a reaction in the vertical plane of the bar. The recovery of the slipping action causes an opposite reaction. These two variations in loading cause the product to loop and when the loop is at or near the front end of the bar, handling into the next pass can be very difficult.

Also, the unequal loading has the disadvantage in that considerable overpowering is required to allow rolling at maximum speeds on the larger sections. Where normally a 6000-hp motor with pinions may be required to produce a shape at a required speed, two 4000 to 6000-hp, twin-drive motors may be required to operate at the same rate. This is due again to the unequal loading of one motor.

Louis Moses: It is difficult to express a roll designer's reactions when he is asked to alter, materially or otherwise, a successful rolling scheme to accommodate a particular phase of automation. Being as keenly interested as anyone else, he does not arbitrarily dismiss the proposition and recognizes the sought for advantages.

Dealings with automation engineers have been gratifying because of their capable grasping of the numerous factors which are present in rolling operations. They have carefully considered the range of rolled products, finding a particular one which is optimum with lighter or heavier weights or sections offering varying rates of production. There are various reasons making this common to every type of mill.

However, the automation engineers may not immediately recognize, or appreciate, the complex factors affecting metal flow which enters into changes to a system of passes and rolls solely aimed, for instance, toward establishing a uniform delivery speed for every kind of product, or some other feature desired in the delivery-table system. It can well be that to do so would require reconciling a multiple set of changed conditions which could affect, if it did not hamper, the forming of the section itself, i.e., create indifferent flange heights, leg lengths, piling fits and tolerances or even extend to the number of passes and finished rolling temperatures. Physical or economical limitations of the drives, roll materials, roll sizes, etc., can be involved.

The primary objective of a mill is to roll consistently reliable products. Looking backward over a long experience one pertinent observation holds: there is more than one way to roll a commodity. Roll designers are versatile; should one rolling scheme not produce the desired results, they will find another. In doing so the abovementioned considerations must be appraised, and time taken to carefully think through the matter, weighing the effects relative to the desired objectives of the automation problem.

J. Raymond Erbe: The authors stated that the control, supplied for the 53-in. blooming mill, stores the punched card information in a magnetic memory, whereas the 34-in. structural mill uses the card itself as the memory. Since they did not explain this, it should be pointed out that the magnetic memory is used because of the mass of data required for the 53-in. blooming mill. As pointed out by the authors the screwdowns, the manipulators, the manipulator fingers, the mill entry speed and the mill acceleration rate are all programmed so it is readily seen that when the maximum schedule of 29 passes is used it becomes impossible to punch this information on a single card. Actually ten passes are punched on a card, with the result that most schedules require a total of three cards, which are read into the magnetic memory. Had it been possible to have gotten all of the information on a single card, the magnetic memory would not have been used.

Another interesting feature of this mill is that the screwdown has a maximum speed of 600 in. per min, which is believed to be the highest speed at present. The screwdown has a 60-in. opening and positions to an accuracy band of $+\frac{1}{32}$ in. The screws always come to rest in the downward direction without overshoot. ▲

5-Zone Reheat Furnace— South Works

by GEORGE H. KRAPF
Division Superintendent
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South Works
United States Steel Corp.
Chicago, Ill.

. . . . uniform heating and ease of control have permitted these furnaces to supply a high-capacity, highly-automated structural mill with properly heated blooms during fast rolling schedules and during periods of low production . . . .

THE continuous-type cold bloom reheating furnaces which have been installed to serve the 34 to 46-in. standard structural and wide-flange beam mill at South Works, the reasons for choosing the 5-zone design rather than the conventional 3-zone design, and a review of the more interesting design details are discussed in this article.

These furnaces and the attendant structural mill are parts of a large department which also includes a blooming mill and associated soaking pits. All of these facilities are newly constructed. All were designed together in main features: ingot weights, bloom dimensions, roll pass designs and rolling schedules, number and speed of mill stands; rolling rates, general dimensions, approximate heating capacities of the furnaces and the number of furnaces, all were determined in broad outline prior to any detail consideration of the furnaces themselves.

The bloom sections to be heated varied, but were to be approximately rectangular in cross section, up to

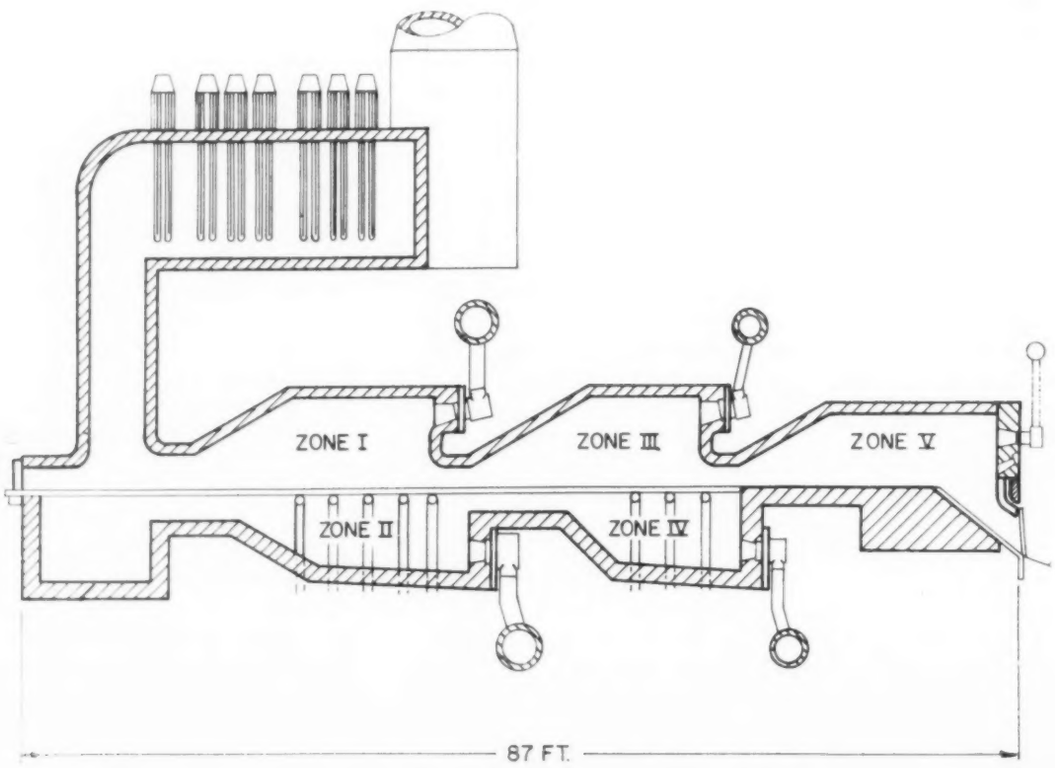


Figure 1 — The 5-zone furnace and the recuperator are shown in cross section.

38 ft long and from 6 to 12 in. thick. The maximum rolling rate for the initial installation was expected to be about 300 tons per hr, with possible increases to about 450 tons per hr if the additional mill stands should be installed. Thus, two furnaces were installed, with space provided in the event that a third might be needed.

All of the standard structural shapes and wide-flange beams include one or more re-entrant angles in their cross sections, and the pass designs and rolling schedules aim at uniformity in elongation in each pass. This includes, for many sections, the creation of deliberate but controllable "spread," although this kind of control is not positive. The best results are achieved only when the temperature distribution is constant throughout each piece and all pieces for one rolling are delivered at the same temperature.

It was expected that the operating schedule would include in a typical 8-hr turn a number of delay periods for changing ft-weight, size or section with the consequence that the heating operation would be intermittent.

The desire to achieve the highest degree of uniformity in the temperature of discharged hot blooms from intermittently-operated, large size, continuous-type furnaces was the principal factor in deciding the features which preferably the furnaces should have.

The 5-zone furnace concept (Figure 1) came closest to this desire, since this one furnace design could handle a variety of bloom sizes and lengths, and could produce the mill tonnage requirements on demand. This design lent itself to full tonnage rate after a section change because the cold steel entering the furnace can be heated at the proper rate with the first two zones, permitting this steel to enter the next two zones, for further heating, and the soaking zone at the required temperature without danger of over or underheating. Then the soaking zone can operate for the specific purpose of soaking steel and assure delivery of uniformly-heated blooms to the mill.

Even more important was the fact that there would be no need to set the temperature so high in the heating zones, when the furnaces were being pushed at high tonnage rate, that there would be danger of overheating in case of a change in pushing rate or a mill delay. It was believed possible that very little change would be necessary in the temperature setting of the zones to account for variations in pushing rates or for bloom sizes, thus reducing the problems of the operators.

REFRACTORIES CONSIDERATIONS

Plant operating and maintenance experience with continuous furnaces favored using plastic-type refractories for the roofs and side walls of the four heating zones. The soaking zone, in consideration of the need for maximum degree of uniformity of temperature in the heated blooms, was lined with semi-silica high refractory firebrick to obtain the advantage of a high radiation reflectivity brick.

ZONE CONSIDERATIONS

In view of the desire to heat the incoming steel as rapidly as possible the zones were proportioned as follows: No. 1 zone, 30 per cent heating volume; No. 2 zone, 26.2 per cent heating volume; No. 3 zone, 25.8 per cent heating volume and No. 4 zone, 18.0 per cent heating volume. These percentages do not include the volume of the soak zone, because it is not considered a heating zone. Burners were designed to fire 90,000,000 Btu per hr in No. 1 zone, 120,000,000 Btu per hr in No. 2 zone, 40,000,000 Btu per hr in No. 3 zone, 60,000,000 Btu per hr in No. 4 zone and 20,000,000 and 30,000,000 Btu per hr in No. 5 zone, which has two rows of burners. The need for the additional complement of burners will be discussed later.

To obtain more uniformity of heat distribution to the product, the zones were offset, see Figure 2. The burner wall of No. 3 zone was offset 2 ft-9 in. toward the charge end from the burner wall of No. 4 zone. No. 1 zone burner wall was offset three ft toward the charge end from the burner wall of No. 2 zone, see Figure 3. This accomplished the corresponding offsetting of the burner "hot spots" to reduce local overheating from this source.

BURNER CONSIDERATIONS

Attention was paid to the problem of air infiltration at the dropout of the soaking zone a problem which is inherent in a front-discharge continuous furnace, yet this problem had to be solved if the mill was to receive uniformly-heated blooms. The problem was solved (Figure 4) by installing under the regular burners in this zone, a row of "blanket" burners pointing down at an angle so that the "line of sight" is aimed just below the apex of the discharge end of the soaking hearth. It was thought that the resulting localized area of higher temperature would prevent the chilling of the face of the bloom. In addition by proper adjustment of the fuel to air ratio of these burners, the oxygen in the infiltrated air could be consumed at this point. This aids in obtaining the desired combustion product analysis in this important area, where the bloom is at rolling temperature and sensitive to this factor.

The heating zones of a 5-zone furnace are relatively short, and it was important that all the gas fired in each zone be burned in that zone. In addition, because of the

Figure 2 — The heating zones were offset to equalize heat distribution.

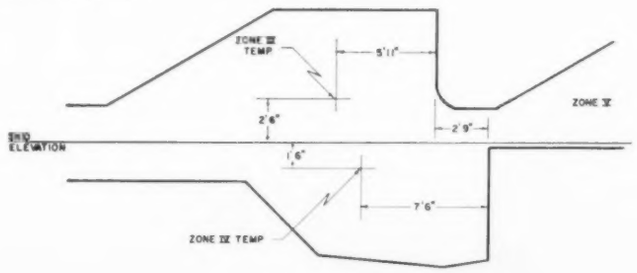
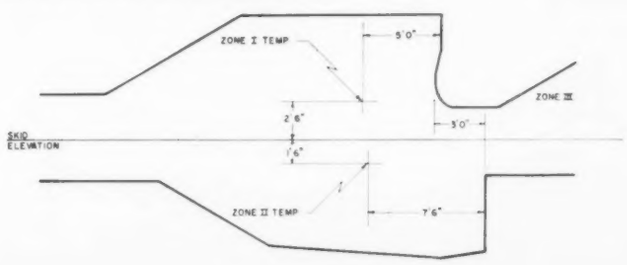


Figure 3 — Local overheating was reduced by offsetting the zone 1 burner wall three ft.



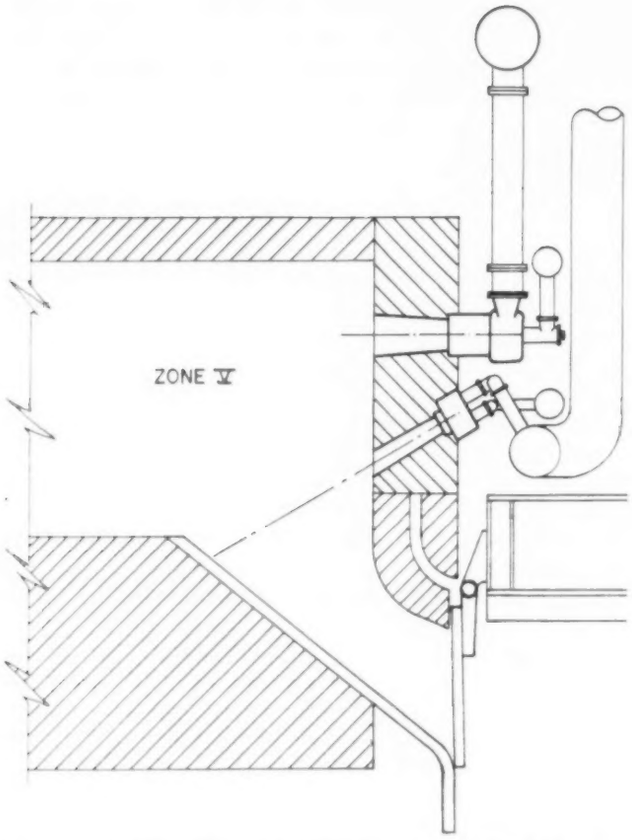


Figure 4 — Burners were installed at the dropout to prevent chilling of the edge of the bloom.

furnace configuration it seemed that it would be possible to gain recirculation in the zones to aid in uniform heating if high-pressure, high-momentum burners were installed. Such fast mixing "clear" flame burners also made possible the use of an advantage inherent in the refractories in these zones. Plastic refractories, when heated, have relatively high radiation emissivity. They have the ability of receiving the short wave length radiations of water vapor and carbon dioxide and converting these to longer wave length radiation in the red spectrum. These longer wave length radiations are good transmitters of heat energy to the steel and the clear flame is almost transparent to them. High-momentum, fast-burning, clear flame burners in these short zones approach the desired end of all the refractory surfaces being at a uniform temperature due to the combination of radiation and circulation, which will result in uniform heating of the steel. To obtain this result, air was supplied to the burners at 2.9-in. water column.

PIPING CONSIDERATIONS

It was recognized that the success of this wide (40 ft) furnace was vitally dependent upon temperature distribution across the furnace.

It was necessary that desired temperature control of each zone be provided by the use of a single measuring element. This could only be done by assuring constant uniformity of heat release across the zone regardless of the firing rate, without the necessity of constant adjusting of individual burner "trim" which would present the heaters with an impossible operating situation. In order to accomplish this objective, proper and adequate air and fuel distribution to the individual burners had to be provided.

Figure 5 shows the arrangement of the piping for the distribution of combustion air to the various zones to accomplish the desired results. This diagram also displays an ingenious method of furnishing the desired temperature distribution of the combustion air to these zones.

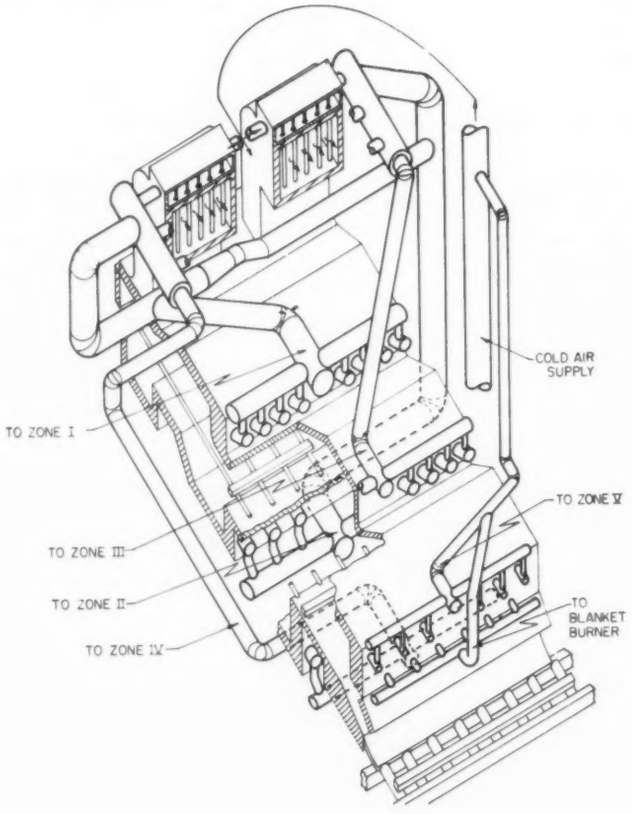
The proof of any design is in the operating results. It has not been necessary to trim any burner on these furnaces to obtain the required uniformity of heat release at any level of activity.

RECUPERATOR CONSIDERATIONS

In order to provide the proper distribution of the heating gases under and over the blooms in this furnace, it was necessary to provide two uptake flues. A recuperator was installed on each flue designed to heat 45,000 cfm of combustion air with waste gas at a temperature of 1900 F. Advantage was taken of the configuration of the recuperator installation to obtain a unique combustion air distribution to the various zones, see Figure 5.

Heat release supplied at too high a flame temperature may cause overheating of bloom surfaces in the hot zones which forces a cutback of heat input, when this cutback is not desired for production reasons. On the other hand, cold steel will absorb heat at such a rate from a flame that it is almost impossible to get too high a flame temperature at the incoming end of a high productivity furnace. Therefore, in the cold end of the furnace a high heat head was desired, and in the hotter sections of the furnace, correspondingly lower heat heads were desired.

Figure 5 — Combustion air temperature is regulated by the furnace rate.



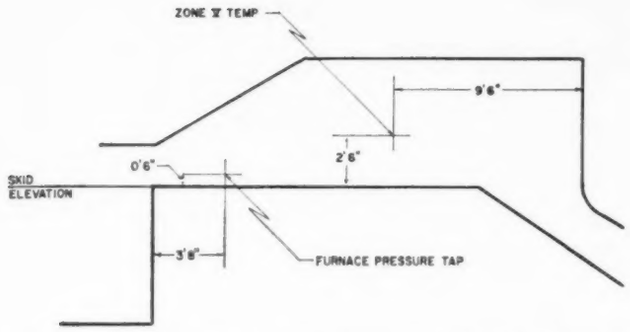


Figure 6 — The zone 5 thermocouple and the furnace pressure tap locations are illustrated.

The recuperator, installed above the furnace, is of such design that the hot furnace gases pass over the tubes from the back to the front in relation to the furnace. The combustion air flow and the gas flow are countercurrent. Therefore, the hottest air is obtained from the hot end of the recuperator which is the cold (charge end) of the furnace. Thus, it was simple to remove combustion air from the recuperator at two points, the hottest air being ducted to zones 1 and 2 and the cooler air to the intermediate zones 3 and 4. Cold air is supplied to the burners in the soak zone, to provide the practical minimum flame temperature in that zone.

CONTROLS

It was believed that very few changes would be required in temperature settings for different operating rates. With the hope that the efforts to produce uniformity in each zone would be successful, it was decided to control temperature from one thermocouple mounted in the side wall of each zone. Figures 2, 3 and 6 show the thermocouple location in each zone.

The temperatures at these various points are recorded on controller recorders, which control the fuel input to the various zones to maintain the desired temperature. Combustion air flow, temperature compensated, is a function of fuel flow so that the proper fuel to air ratio is obtained.

Furnace pressure is controlled from a pressure tap in zone 5 as indicated in Figure 6. The controller modulates the flow of ejection air to the ejection stack and a damper installed near the top of the stack. The method of operation causes the draft to be reduced first by reduction of ejection air to a band where the stack damper starts to operate. As the need for draft further decreases, the ejection air will stop reducing at a minimum setting and the damper will continue to close to obtain the desired results. The procedure is reversed as more draft is needed on the furnace.

These furnaces are protected against loss of: combustion air, supply, fuel, control air, ejection air supply and against power failure by a series of detection devices and interlocks. Past experience indicated the desirability of informing the operator as to the point of failure when the furnace shuts down due to the operation of one of the protective devices. An annunciator board was installed in each furnace system to give the operator this information.

Figure 7 shows a control panel for one of the furnaces and Figure 8 shows the position of the air-conditioned control room in relation to the furnaces.

WATER SUPPLY

One other problem had to be investigated. Water was in reasonable supply in the area, but the lines did not have unlimited capacity. It was necessary to consider using the water after it had passed through the furnace for further use by the mill, in such applications as scale flushing, roll water sprays, etc. To accomplish this, plant water is boosted to the pressure required to provide adequate cooling of the various skids, skid supports and lintels; is collected in a manifold and is discharged downstream into the mill system. Small sample lines are connected to each discharge and piped to a bosh so that the operator can test the water temperature leaving each point at a convenient area and adjust the flow accordingly.

All skid pipes and skid pipe supports were insulated to conserve heat and water. The skid pipe support design incorporated the discharge flow coaxially with the supply to reduce the exposed surface area inside the furnace. The estimated water consumption is 1550 gpm per furnace.

THE FURNACE

Table I and Table II tabulate most of the combus-

Figure 7 — All furnace controls are enclosed in an air-conditioned pulpit.

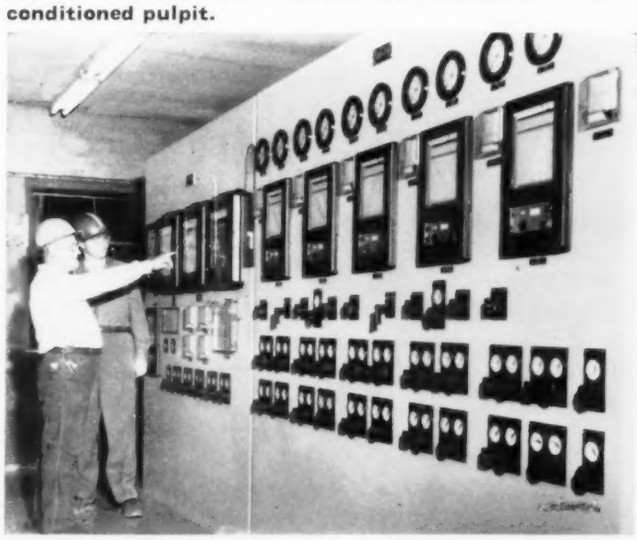


Figure 8 — The control room was centrally located to hold control wiring and piping lengths to a minimum.

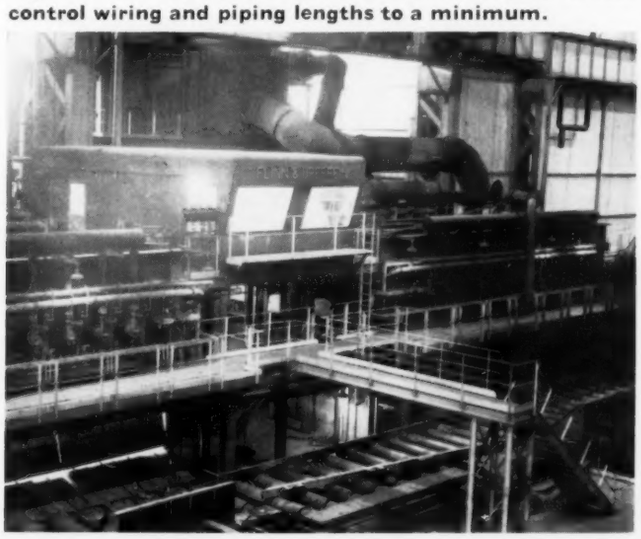


TABLE I
Combustion Data

	Zone I	Zone II	Zone III	Zone IV	Total zone V	Sub zone V_A	Sub zone V_B	Furnace
Total Btu per hr	90 x 10^6	120 x 10^6	40 x 10^6	60 x 10^6	50 x 10^6	30 x 10^6	20 x 10^6	360 x 10
No. of burners	10	10	10	10	...	12	24	...
Volume of combustion chamber, cu ft	5,590	4,856	4,770	3,355	5,012	...	...	...
Size of burners	14 in.	16 in.	10 in.	12 in.	...	6 in.	301-1	...
Firing rate, Btu per cu ft	16,100	24,700	8,360	17,900	9,950	...	...	...
Burner air pressure, in.	2.9	...	2.2	...	...	...	...	...
Burner air temperature, F	925	925	725	725	60	...	...	...
Burner pipe								
Air, in.	14	16	10	12	...	6	3	...
Gas, in.	4	4	3	4	...	2	1¼	...
Oil, in.	½	½	½	½	...	⅜	None	...
Air per zone, cfhr x 10^6	2 at 850 F	2.67 at 850 F	0.89 at 850 F	1.34 at 850 F	0.4 at 70 F	0.27 at 70 F	0.13 at 70 F	...
Air per burner, cfhr	200,000	267,000	89,000	134,000	...	22,500	5,420	...
Gas (1060 Btu) per zone, cfhr	85,000	113,000	38,000	57,000	41,500	28,000	13,500	...
Gas per burner, cfhr	8,500	11,300	3,800	5,700	...	2,330	565	...
Oil (150,000 Btu) per zone, gphr	600	800	270	400	200	200	None	...
Oil per burner, gphr	60	80	27	33⅓	...	16⅔	None	...
Steam per zone, lb per hr	3,000	4,000	1,350	1,650	1,000	1,000	None	...
Steam per burner, lb per hr	300	400	135	165	...	83	None	...
Air header ID, in.	32	36	22	26	...	16 from 18-in. supply	10	...
Gas header ID, in.	14-10	10	10-8	10	...	8	6	...
Oil header ID, in.	1¼–1½	1¼–1½	1¼–1½	1¼–1½	...	1–1¼	None	...
No. of air control valves	2	2	2	2	...	1	1	...
Air control valve, in.	32	36	22	26	...	18	12 manual	...
Gas control valve, in.	10	12	8	8	...	6	4	...
Oil control valve, in.	1	1	1	1	...	1	None	
Steam, oil ratio regulator, in.	2	2½	1¼	1½	...	1¼	...	...

tion data and important dimensions of this 5-zone furnace.

SUMMARY

From a very limited experience with sustained high production to date, these furnaces indicate that they will materially exceed their designed capacity of 173 tons per hr with 12-in. blooms and 195 tons per hr with 6-in. blooms.

The problems of starting a structural mill of the design of this high-capacity, highly-automated mill have been many, but the furnaces have been relatively easy to control in spite of periods of long idleness followed by fast rolling.

The efforts to incorporate in the basic design, factors to obtain uniform heating has paid off. The heating has been good from the very start. With a 40-ft wide furnace, it has not been necessary for the furnace operators to trim burners to obtain uniformity, and very little change is necessary in temperature control setting. Fuel rates will have to be reported when the mill reaches an operation close to sustained production.

It is felt that all the efforts, ideas and experience that have been poured into this furnace design are being repaid.

TABLE II
Furnace Details

Zones →	1	2	3	4	5
Length, burner face to end of knuckle, ft-in.	25-8¾	28-5¾	23-3	23-6	25-0
Height, maximum, ft-in.	8-0	7-0	8-0	6-10	6-6
Width, ft-in.	40-3	40-3	40-3	40-3	40-3
Two uptake flues, each	5 ft-6 in. long by 11 ft-2 in. wide				
Total furnace length inside brick to inside brick	85 ft-3 in.				
Total furnace length, charging door to apex of dropout	80 ft-3 in.				
Recuperator	Metallic split type				
Combustion air blower	72,000 cfhr at 30 in.				
Combustion air blower prime mover	400-hp, class B7, 1800-rpm, totally-enclosed, forced-ventilated motor				

Discussion

PRESENTED BY

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GEORGE H. KRAPF, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

HENRI A. MEYJES, Superintendent, Hot Mill, Breedband N.V., Ijmuiden, Holland

JOSEPH WAITKUS, Manager, Special Applications, The Air Preheater Corp., Wellsville, N. Y.

FRED BLOOM, President, Bloom Engineering Co., Pittsburgh, Pa.

THOMAS E. DIXON, Vice President, The Griscom-Russell-Schack Co., Inc., Pittsburgh, Pa.

John B. Mitchell, Jr.: Campbell works is in the process of building three 5-zone reheat furnaces, which

are part of the revamping of the existing hot strip mill. It is planned to heat slabs ranging from 3 to 15 tons in size. What method is used if there is a pile-up in the furnace?

What type of insulation is used on the water-cooled skid pipes and how successful has it been?

How high is the water pressure in the cooling pipes? Are there any auxiliary facilities for higher pressure in case of a plugged line?

What is the amount of time required to reach rolling temperature when starting a cold furnace?

George H. Krapf: Every effort is made to avoid pile-ups by charging the blooms so that, as much as possible, the flat sides are doing the pushing. This generally means that the shear drags are up or down with blooms that are close to square in cross section. On blooms with rectangular cross sections it is sometimes expedient to charge on edge so that the pushing is done on the side of greatest dimension. If a pile-up does occur and can be reached by slings from the charging end, the fuel is shut off and the blooms are withdrawn with the pusher. If the pile-up occurs beyond this point, which does not happen very often now, there is nothing to do but push it through the furnace and hope for the best. All knuckle heights will clear a stack of two of the thickest blooms with in. to spare.

The vertical support pipes are insulated with two general types of material. One consists of a stack of interlocking doughnut refractory shapes. The other is castable refractory cast into a sleeve surrounding the vertical pipe. Both types tend to split vertically, usually with the crack at the six and nine o'clock position with the burner at the 12 o'clock point.

Horizontal skid pipes are insulated with prefabricated cast-type insulation in which is imbedded stainless steel mesh. This insulation is purchased cast to fit and is applied to the skids by welding the stainless mesh to the skid pipes, or as in the latest design is hung over studs in two halves. This latest design seems promising.

Insulation and its upkeep is no small item of cost, but it will pay for itself in six months or less in fuel savings alone. Of more importance is that with the amount of water-cooled supports and skids required in such a furnace, insulation of the skids is an operating must, if proper heating of the bottom of the bloom is to be attained.

Water pressure is approximately 36-psi gage. Higher pressure water from a fire pump line is available to the furnace, but was installed primarily as an emergency water supply. Plugged skid pipes have not been a problem, but the high-pressure water is available if needed.

It has been found that 24 hr is desirable to bring a furnace of steel from cold to rolling temperature especially if the hearth is cold. Getting the heat through the steel and heating the hearth so that the blooms do not have serious temperature gradients is the problem.

Henri A. Meyjes: What determines the correct location of the thermocouples? Is the hot spot not in the burner?

What determines the location of the thermocouples in the side wall of the furnace?

Are you using soft water or is it necessary?

There is a tendency to increase productivity and increase heating. If production is increased the heating is doubled or tripled, but it is still necessary to cope with the substantial difference along the skids, and as long as the hearth section in which the slab is equalized is not lengthened, it is not felt that an increase in firing can have much influence on the furnace output.

George H. Krapf: Selection of thermocouple position was based on experience and observation from working with other furnaces of this type. A spot was selected that would be meaningful in regard to steel temperature and be in position to recognize maximum flame temperature. It was designed to pick up average steel temperature and not the bloom end temperature, for this reason it is located above the top product level. It was designed to pick up average furnace temperature; therefore, it is located in the side wall, since a roof location would only pick up flame temperature. It was also designed to receive radiation from the flame, in order not to overheat the furnace or the steel. Therefore, it is located some distance back from the burner face. If such a position will "repeat," in other words, if the steel will always come to the same temperature range with a given control setting, then the thermocouple position is close to optimum. Sometimes a lot of experimenting is required to find these spots in a given furnace. However, the original locations were close.

It is not necessary to treat or soften the water that is used for cooling these furnaces. Lake Michigan water is low in hardness and contains little or no algae. It is a very desirable water because of this. The water is passed through basket strainers ahead of the furnaces to remove small floating debris and fish that get past the intake screens.

Skid marks are of course more of a problem with a product heated in high-productivity furnaces. The problem is minimized if the bloom is well heated by the time it reaches the soaking hearth. This is one of the reasons for using the 5-zone furnace design. The blanket burners described also help in overcoming this problem.

That the problem has been minimized is proved by the appearance of the steel as it enters the structural mill and by the dimensionally uniform product rolled.

Joseph Waitkus: Is any measurement made of the uptake temperature before and after the recuperator?

According to the combustion data, the air temperature is around 925 F as a maximum. Would a higher air temperature, 1000 to 1200 F, be of any particular benefit in the operation of this furnace?

What is the character of the entrainment in the gases entering the recuperator? Are there any plastic, heavy or solid materials in the gases?

George H. Krapf: The flue gas temperature drop is approximately 600 F at the present time. The flue gas inlet temperature is approximately 2000 F.

A higher air temperature is of value in any heating application, depending on the method of application. It is primarily useful as a fuel saving device and this is the reason a heat recovery apparatus is installed. This saving must be evaluated against the investment in recuperators required to obtain higher air temperature. Factors in such a determination include unit fuel cost and the exit flue gas temperatures expected. High-

productivity continuous furnaces such as the one described, by this very fact (high productivity) will have relatively high exit flue gas temperatures. A greater investment in recuperators can be justified on such a furnace than on low-productivity furnaces with relatively lower exit flue gas temperatures. The method of application that has been explained in this article is designed to obtain the maximum benefit from the recuperator investment by permitting a higher preheat for the cold end of the furnace where it is most beneficial, since it would aid in higher heat transfer rate to the cold steel.

On the hot end of the furnace, the value of air preheat is questionable, since heating of the product is not the major factor. The primary consideration in this area is uniformity of heat distribution, minimum scale formation and formation of scale of a desirable character.

There is no carry over of product scale in the flue gases.

Fred Bloom: A furnace is no better than the design of the combustion system and the location and volumes of the multiple zones which make up the structure. We know that the author and his associates spent many hr going over many calculations before deciding on the final furnace arrangement.

How well are you satisfied with zone capacity and zone location?

Can you use all the fuel provided in each zone or is there a shortage of fuel in one location and a surplus of fuel in another location?

If another furnace was required, what changes would be made?

George H. Krapf: There is no reason at the present time to be dissatisfied with zone capacity or location or with the volume of fuel provided for the various zones. With more experience, design changes of furnace lines, zone sizes, etc., may be suggested.

An important design change in the skid supporting structure is presently being made. The brick piers are not satisfactory because they tend to disintegrate under the saddles of the skid pipes. On No. 1 furnace, the refractory supports between zones 2 and 4 and on the slope of zone 2 have been replaced with insulated, water-cooled pipe supports. In rebuilding No. 2 furnace, all of the refractory skid support walls were replaced with insulated, water-cooled pipe supports.

Thomas E. Dixon: The wide range of probable flue gas entry temperatures which recuperator builders were given by the several furnace builders, as a basis for the recuperator design are recalled. Since there were few operating results available at that time on 5-zone furnace operation, it was not really surprising that figures varying from 1800 to 2300 F at the entrance to the recuperator were encountered. Under the circumstances, obviously only one figure could be used, and performance was then predicted throughout the rest of the given range. The author has indicated that the recuperator flue gas entry temperature is about 1800 F, and the air preheat about 800 F. Peak flue gas entry temperatures of 2000 F were mentioned.

Would the author care to predict what the recuperator flue gas entry temperature might reach when the furnaces are operated fairly consistently at full capacity?

Is any attempt made to control the recuperator inlet temperature to any predetermined maximum, and if so, what control method is used?

The use of different air temperatures at the various burner locations is very interesting. Would the author please indicate when the maximum air preheat is 800 F, what air preheat temperatures are obtained in the other recuperator sections?

As is well known, the pressure at which the furnace hearth is operated clearly affects the volume of flue gases arriving at the recuperator. The volume of flue gases passing through the recuperator is equally as important as the flue gas entry temperature, since for a given air volume and preheat, it affects the temperature of the flue gases leaving the recuperator and hence, the area of heat transfer surface needed. For a given flue gas entry temperature and a given air volume and preheat, the more the flue gas volume falls below the theoretical figure, the greater is the heating surface required to perform the required duty. Thus the "blanket" burner innovation is of interest. Have any heat balances across the recuperator been made which might help to determine what percentage of theoretical flue gas volume is flowing across the recuperator?

George H. Krapf: A maximum flue gas temperature of 2100 F is being experienced at pushing rates equalling full design capacity.

There is no arrangement to control inlet temperature of the flue gases; moreover, it is not felt that this is the proper attack of the implied problem. The consideration at this point is maintaining allowable surface temperature of the recuperator tubes. This can be accomplished by adequate combustion air fan capacity and pressure to permit required cooling of the recuperator internally, and the exhausting of some of the air to the atmosphere if necessary. In instances in which air has been introduced into the flue gases to limit exhaust gas temperatures to protect the recuperator, this air was introduced into a mixture of exhaust gases containing combustible products and additional heat was released at the recuperator which added to the problem.

With air preheat to zones 1 and 2 of approximately 900 F, the air preheat to zones 3 and 4 is about 800 F depending on how hard these zones are being fired.

With properly applied furnace pressure controls, and reasonable attention given to the design and maintenance of the charging and discharge doors of the furnace, the effects that Mr. Dixon has outlined can be greatly reduced, so that this infiltration is minor. The original design considered this, and the blanket burner design is a case in point. The flue gas volume calculations considered the volume of products from the blanket burners. These burners are operated to consume the air infiltrated into the furnace at the discharge end.

No real heat balance across the recuperators has been made. However, the volume of gases across the recuperator has been determined, and has been found equivalent to the firing rate of the furnace at approximately 20-per cent excess air to the burners plus approximately 100-per cent air infiltration at the charging doors. There has been no difficulty in controlling furnace pressure to maintain these figures. ▲

Steps Toward Coke Plant Automation

by N. F. AGNEW, Vice President, Femco, Inc., Irwin, Pa.

. . . . most of the equipment necessary for coke plant automation has been used in various steel plant applications. The primary problem has been to integrate the available equipment with the system required, since the variations in time and action necessary often preclude the use of preset programming . . . .

THE title of any article is usually a compromise between brevity and accuracy, and this article is no exception. The men who design and manufacture all types of coke plant equipment have taken many steps toward automation which this article will not even attempt to enumerate. It will instead be limited to certain steps applicable to plants as they now exist and more specifically to operations which may be classified as materials handling. It will deal in some detail with a few recent developments which are considered especially significant, and will point out the implications of these developments in relation to other coke plant operations.

Since this last phase involves to look at the future, a prediction comes to mind: Col. George Wiestling, a prominent Pennsylvania ironmaker, wrote just 80 years ago, "We believe that in the blast furnace there are greater possibilities in quantity and quality with charcoal than with any other fuel."

It is felt at this time, at least, that coke will continue to be the dominant blast furnace fuel and that methods of coke production, however much they may be improved, will not differ fundamentally from those known today.

This prediction may be just as wrong as Col. Wiestling's, for no one knows what advances the future may hold. However, the combination of the present knowledge of automatic and remote control systems with the present knowledge of coke plant operations may serve to move the art of coking a few more steps toward the future.

It is the purpose in this article to discuss a few of the problems which have been presented to outline the solutions which have been applied or proposed and to suggest the implications of these solutions in relation to certain other operations. Since each system which will be described was developed in response to a specific

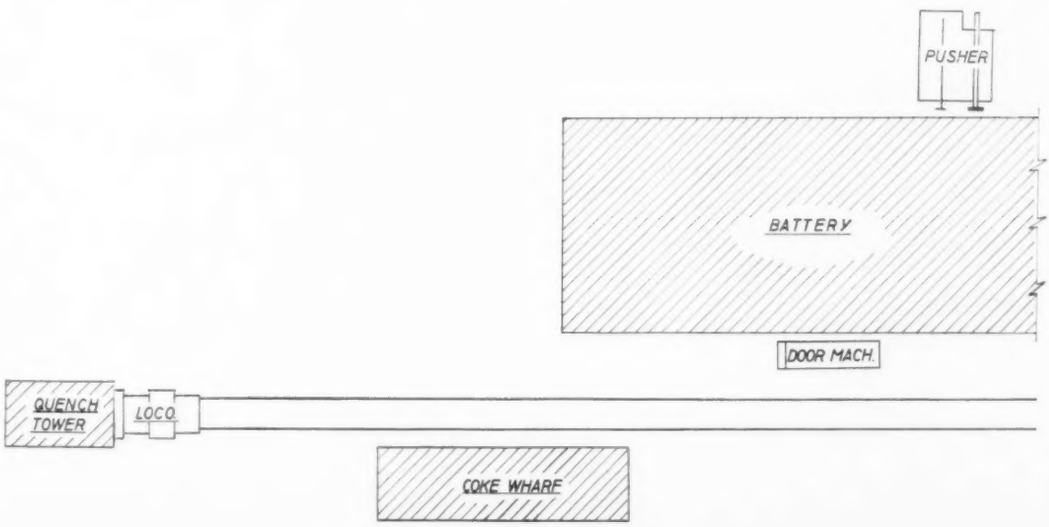


Figure 1 — Automation of the quench car, utilized by the battery shown in the schematic, is a typical problem.

problem, it is unlikely to be a complete answer to any problem, however similar, in another plant. Nevertheless, it is hoped that these descriptions will present ideas which can be adapted and applied to present operations.

In applying or rather extending automation in coke plants, one starts with two important advantages. Practically every operation which it is desired to perform is or can be performed electrically, whether that operation is the opening or closing of a valve or the coke gates on a quench car; or manipulating the controls and applying the brakes on a locomotive.

The other is that the basic "tools" required for automatic and remote control are, for the most part, already available. They have been employed successfully in operations which are just as exacting, and under conditions which are just as difficult, as any encountered in coke plants.

Therefore, the task is primarily to develop systems programming the various steps in the operation and making each operation automatic in response to a specific set of conditions. For practical reasons it is often desirable to stop short of complete automation and leave certain operations under the control of a remotely-located operator. The human mind is still the most efficient and economical "computer" in many situations.

With this preliminary comment out of the way, a typical problem will be examined: automation of a single quench car, serving only one battery, always quenching at the same tower and dumping at the same wharf, see Figure 1. The travel path would always be the same, but there are other variables for which provision must be made in planning a system of automation. Pushing times vary, especially when the oven is a "sticker." Travel distance from battery to quench tower and from wharf to battery differs at each push. The interval between pushes varies.

Because of these variables, programming cannot be preset, but must be a step-by-step process. Each step must be initiated by completion of the one preceding it, or by a signal from the point to which the next step is related and, at certain stages, operation of the quench car must be "tied in" with some other operation.

Combining the coke plant operator's knowledge of what is desirable with the knowledge of what is practicable, gives this operating sequence, starting with the hot car alined under the coke guide:

1. During loading, the car will travel under the coke guide at a rate directly proportional to, and controlled by, the travel of the ram on the pusher machine. Thus, coke will be loaded uniformly on the hot car.

2. When the pusher ram reaches the end of its travel, it will close a circuit which starts the car toward the quenching station.

3. At the quenching station, the car will automatically stop in quenching position. Positioning of the car turns on the water for the quenching cycle.

4. Completion of the quench cycle starts the car from the quench station to the coke wharf.

5. At the wharf, the car will stop and "jog" along the wharf while the coke slides out. At the completion of jog travel, the coke gates close and the car waits at the wharf until the next oven is ready for pushing.

6. When the coke guide of the door machine is in position, it will set up a circuit which starts the car from the coke wharf toward the oven which is to be pushed. This signal for this circuit can also be initiated manually from the door machine.

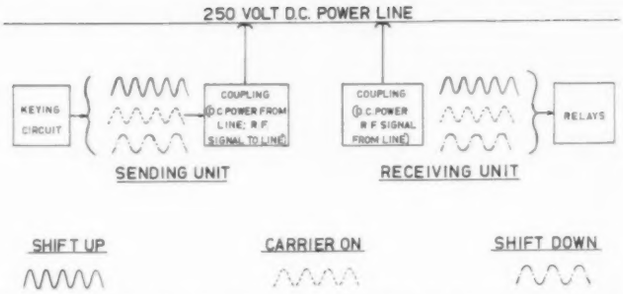


Figure 2 — A carrier frequency, which is imposed on the power line, is used for transmission of travel instructions.

7. As the hot car approaches the door machine, it will slow down, creep along until it is correctly positioned in relation to the coke guide, then stop. A signal is transmitted to the pusher ram which permits the ram to start its travel through the oven.

It will be noted that the system does not require the presence of an operator on the locomotive, and the need for manual remote control by the door machine operator is so slight that he can easily handle the few additional duties.

Some feel that complete or partial automation may be worthwhile even without any saving in manpower. They are inclined to think that operation of the quench car will follow a more uniform pattern and will be more closely co-ordinated with other operations, so that overall efficiency will be increased. This, of course, can be determined only by actual operation experience.

Now, the means by which these various operations are accomplished should be briefly considered.

Carrier shift, that is a carrier frequency which can be shifted up or down by a fixed amount, is used to transmit "start" signals from the door machine to the quench car locomotive. In this particular installation, the door machine may sometimes be north of the quench car and sometimes south of it. The "shift up" impulse is used to initiate travel in one direction, and the "shift down" to initiate travel in the other direction, see Figure 2.

This is essentially the same method that is used in such applications as remote control of electric mules, control of soaking pit covers from overhead cranes, control of cranes from a pulpit, etc. In these applications, however, carrier shift is used in conjunction with a stepper switch or a relay counting chain so that many signals can be handled with only the one carrier frequency. Specifications in this case called for control of only one speed point on the motor control, so these devices were not required.

In other applications, carrier modulated by audio tones might be used. The carrier equipment for this purpose is essentially the same as in the trolley phone, except that modulation is not by voice but by audio oscillators of fixed frequencies.

Normally, carrier systems utilize existing power lines or power rails for transmission. When these are not available (i.e., when locomotives are diesel or battery powered) an insulated wire near the track is used to carry the signal which is "picked up" (or transmitted)

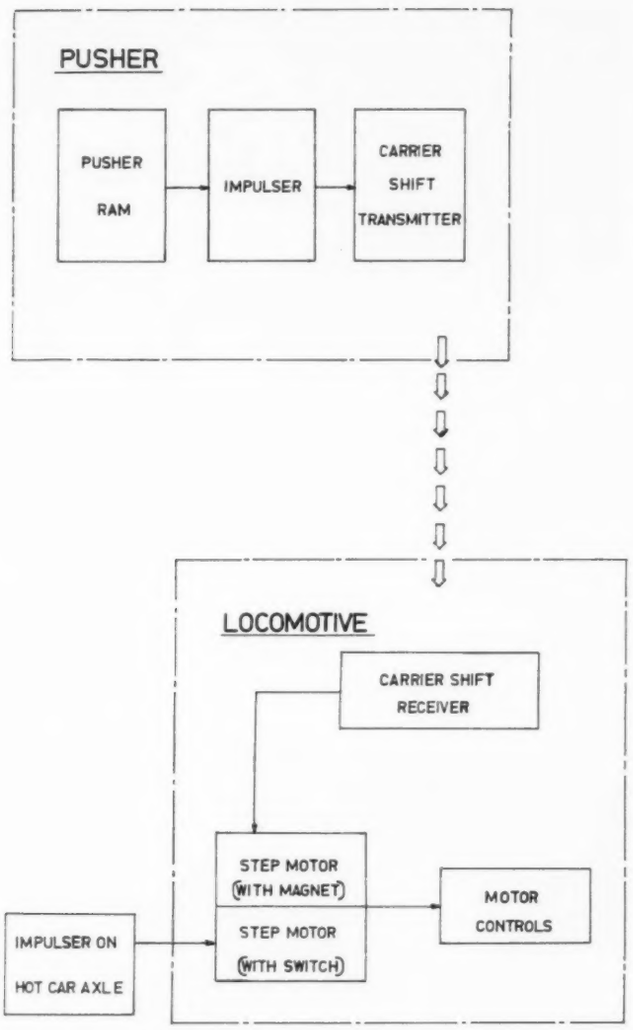


Figure 3 — The schematic indicates the electrical circuit which keeps travel of the hot car proportional to the movement of the pusher ram.

by a loop on the moving vehicle.

Carrier shift is also used to make travel of the hot car under the coke guide proportional to movement of the pusher ram, see Figures 3, 4 and 5. A transmitter on the pusher sends out an impulse each time a tooth on the ram gear engages the rack. These impulses are received by a carrier shift receiver on the locomotive and are fed into a step motor, on the shaft of which is an arm that carries a small permanent magnet.

A second step motor is actuated by an impulse transmitter, similar to that shown in Figure 6, mounted on the axle of the hot car. A reed switch on the arm of this step motor controls the contactor that moves the locomotive.

When the magnet on the ram-actuated step motor shaft approaches the reed switch on the step motor shaft which is actuated by the hot car, the switch closes and the locomotive moves ahead. If the ram hesitates, stops or reverses, the switch gets out of the range of the magnet, opens and the locomotive stops.

Full ram travel produces one complete revolution of the ram-operated stepping motor. Completion of this revolution closes a circuit which starts the locomotive toward the quench tower.

This application of carrier and step motor is new, but

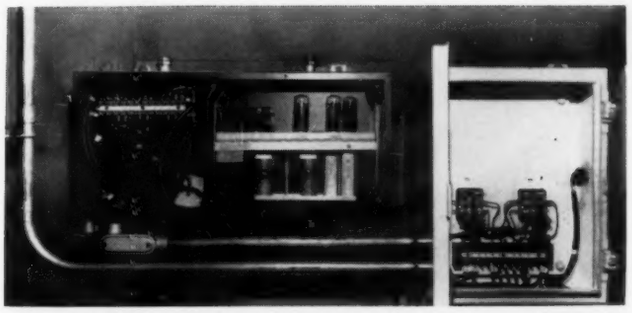


Figure 4 — Mounted on the pusher the equipment on the right receives impulses from the ram-driven impulse generator and directional information from the motor control panel. The output keys the carrier shift unit at left, which controls the step motor in the quench locomotive.

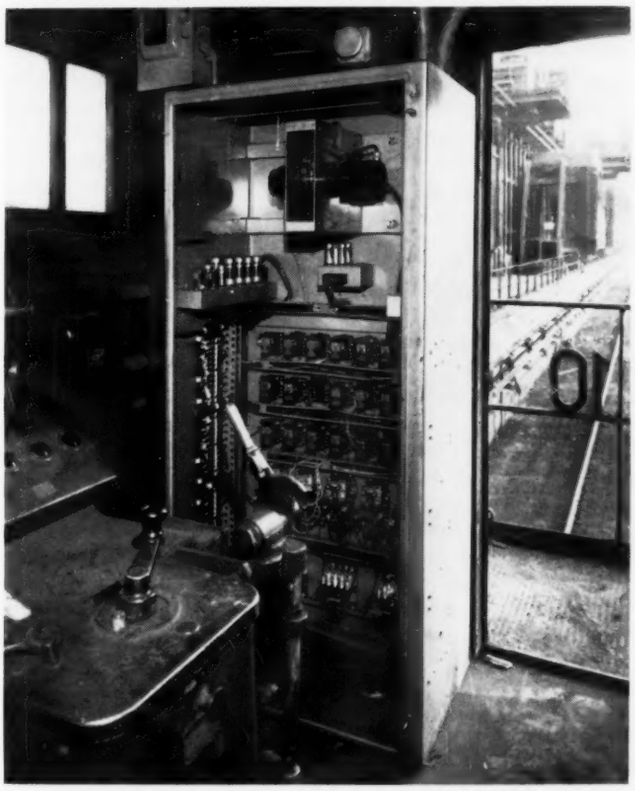
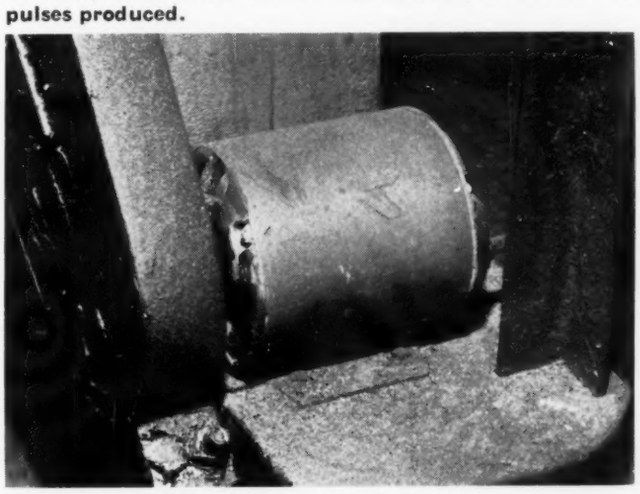


Figure 5 — The equipment cabinet on the quench locomotive houses a step motor comparator (at the top) and on the left is the step motor control chassis which is driven by the carrier shift impulses from the pusher.

Figure 6 — Impulse generators, one shown in center, are used to provide a movement relationship by a count of the pulses produced.



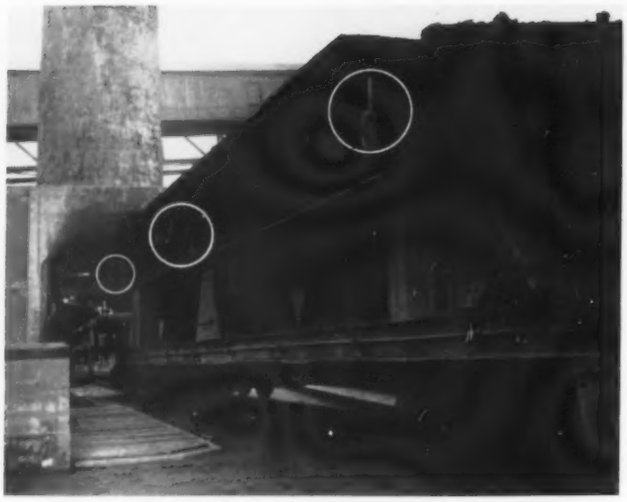
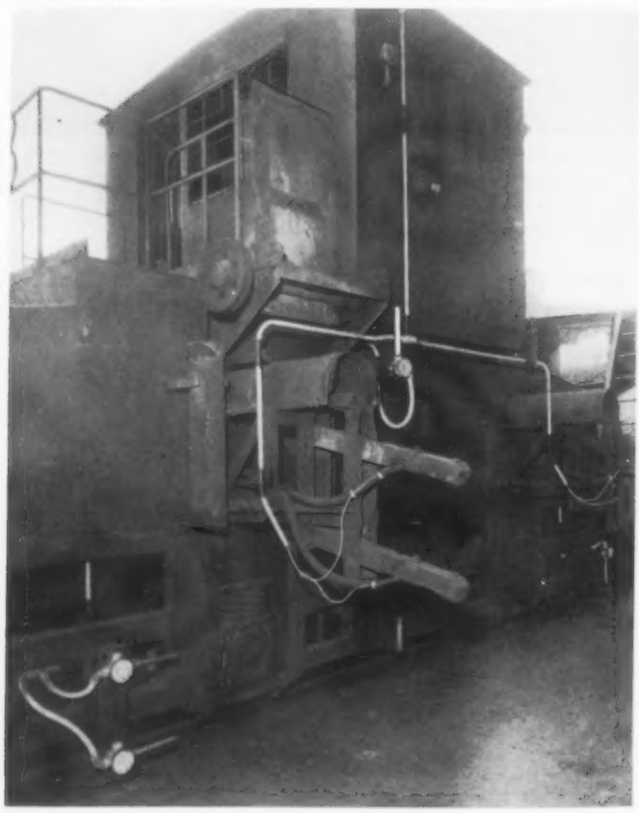


Figure 7 — Limit switch at extreme left, actuated by a permanent magnet on the door machine, provides slowdown when the quench car is called from west of door machine. At the center of the car are the limit switches, which are used to position the car at the door machine and at the quench tower, and the permanent magnet which actuates the "memory circuit" limit switches on the door machine. Limit switch at the right is for westbound slowdown and responds both to a magnet on door machine and a magnet in the quench tower.

Figure 8 — Limit switches and magnets are mounted on the quench locomotive; the two limit switches at the left are actuated by magnets in the dump zones; the switch in the center initiates slowdown at the west of the wharf: the magnet in the center, just above track level, initiates the quench cycle; and the switch at the right starts the locomotive toward the coke wharf after completion of the quench cycle.



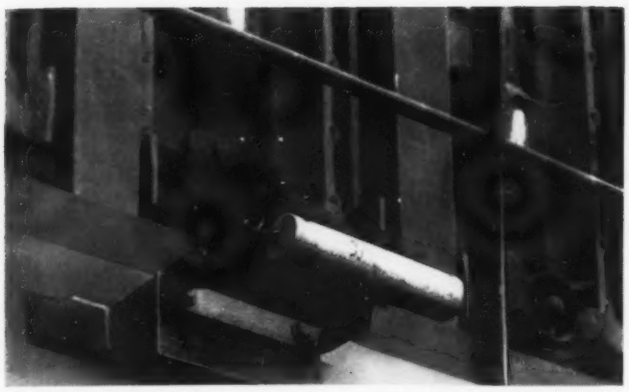


Figure 9 — Permanent magnets operate the limit switches, which initiate the required locomotive action.

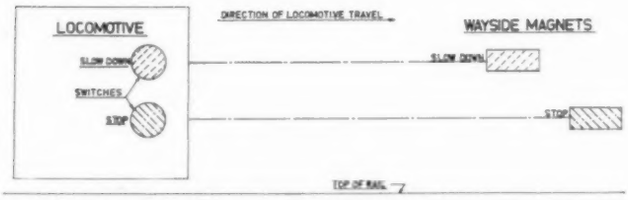


Figure 10 — Wayside magnets initiate slowdown and stop actions at the wharf.

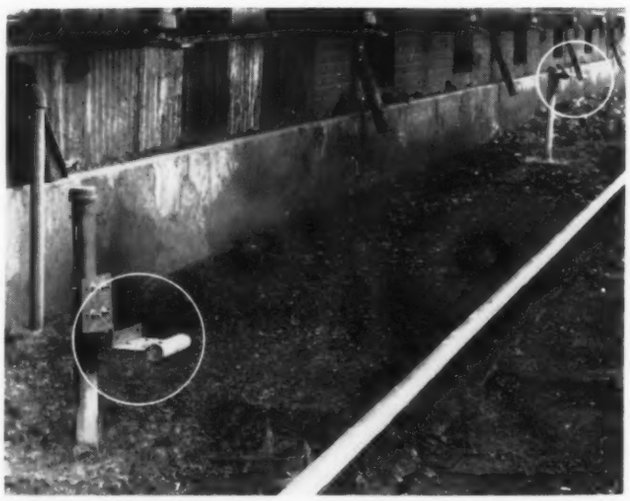


Figure 11 — Permanent magnets are located opposite the coke wharf. Magnet in the foreground at left operates the limit switch which stops the locomotive at the west dump zone of wharf. Magnet at the right operates the switch which stops it at the east dump zone.

it is very similar to others which are already in service. It is, in fact, a simpler version of a method employed as part of a system of automatic ingot buggy operation developed for Kaiser Steel Corp. There it is used to give the operator, in the weighing and turnaround pulpit, a continuous indication of ingot buggy position and to prevent collision when the two unmanned buggies are operated at the same time.

In the Kaiser system, however, the step motors are mounted in the pulpit and each is actuated by movement of one ingot buggy. The circuit is set up so that the buggies stop when the magnet on one step motor shaft comes within a certain distance of the reed switch on the other.

This portion of the quench car automation system has been described partly because it may be least familiar and partly because it is felt that there is consider-

able interest in it as a means of obtaining uniform hot car loading, whether or not other portions of the operating cycle are to be automated. Quite possibly, it will suggest other applications which have not come to our attention.

Slowdown and stop impulses to the locomotive are initiated by magnetic limit switches which are actuated by permanent magnets located at appropriate points along the track. In the quench tower (Figure 7) the same sort of device removes power from the collector rails, turns the quench on and off, then restores power and closes an electromagnetic circuit which, in turn, closes the circuit that starts the locomotive toward the coke wharf. Figure 8 shows the limit switch installations on the quench locomotive.

At the wharf, wayside magnets (Figures 9, 10 and 11) actuate limit switches on the locomotive to slow down and stop the car, open the coke gates, inch the car along the wharf for a predetermined time, close the gates and hold the car in readiness to travel to the next oven.

The door machine operator can exercise manual or emergency control of the car at any time, although normally everything is automatic.

Relays are used to initiate action in response to carrier information or to the position of limit switches, and to time various operations.

The point to be emphasized in all this is that every element in the system has already been used successfully in other steel industry applications. Some modifications have been necessary, but no new components had to be developed. The main task has been to combine components of proved performance into a system which will meet the specifications set by the customer.

Where else can automation be applied in by-product coke plants? While the quench car system was still on the drawing boards, the company was asked to submit a plan for the automation of a battery of Mitchell ovens to be built to supply coke for a chemical plant. At this battery, leveling and pushing are done by separate machines and coke is quenched in the oven, thus eliminating travel to a quench tower, see Figure 12. Otherwise, coal and coke are handled much the same way as in by-product coke plants.

Operation of this battery includes four major functions: (1) removing doors and watering; (2) pushing and loading into cars; (3) charging and leveling; and (4) closing and sealing doors. Operation of the doors will be manual; pushing, loading, charging and leveling will be a combination of automatic and remote control, with one operator on the loader and one on the leveling machine.

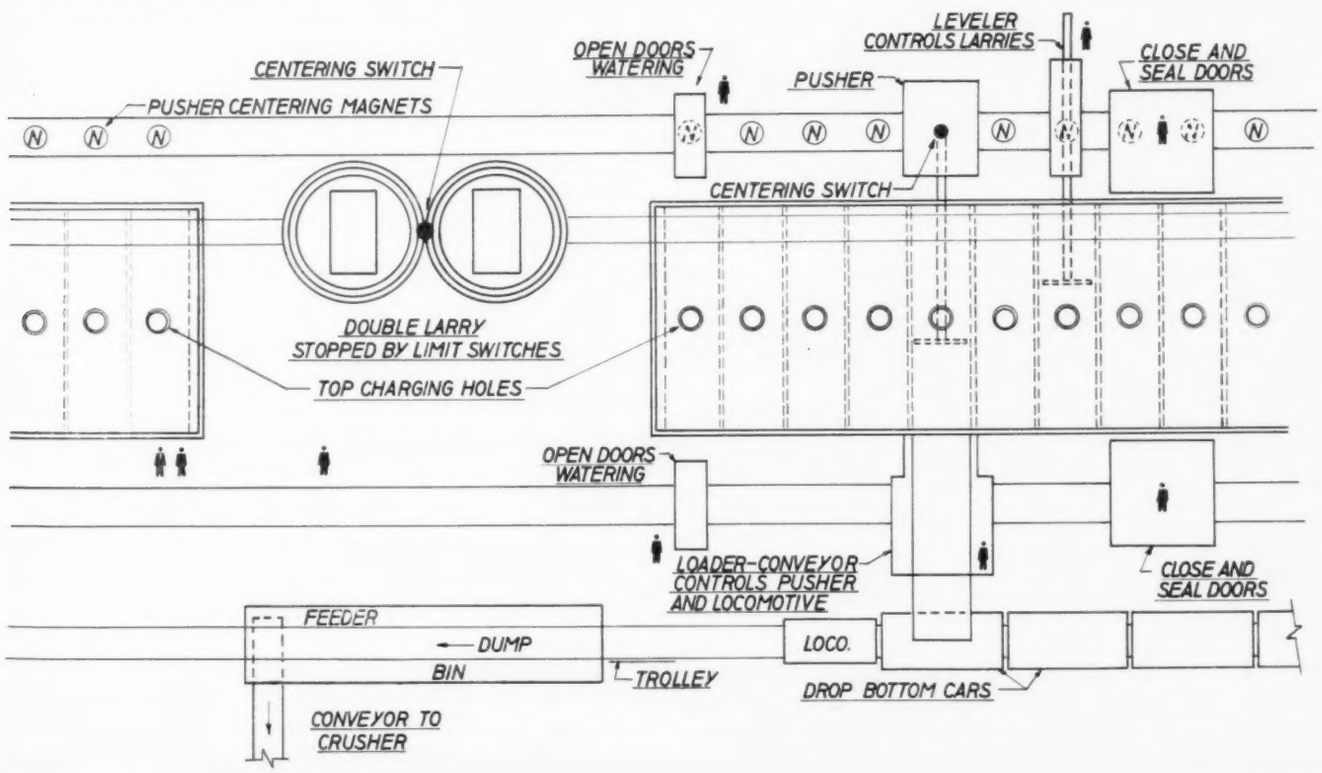
The man on the loader operates the pushing machine and ram by remote control. He positions his own machine manually, then, by remote control, brings the pusher to the center position of the oven to be pushed. When it arrives in position, the pusher automatically lights a centering signal lamp on the loader, indicating to the loader operator that he may now start the ram.

Charging and leveling will be handled by an operator on the leveling machine. The operator on the leveling machine manually positions it at one of the ovens which is to be charged. (The larry car is double, holding a charge for two ovens.) By remote control, the leveler operator positions the larry over the oven for charging.

When the larry car is properly positioned, the leveler operator transmits an impulse which starts the proper conveyor for the dumping operation. After all the coal is dumped, he sends the larry back to the hoppers to receive coal for the next charge.

At the loading bin, centering, loading of each com-

Figure 12 — Schematic layout of a battery of ovens designed for automatic and remote control. Locations of necessary personnel are indicated.



partment of the double larry and return of the larry car to the leveling machine is automatic.

The locomotive which hauls the cars to the bins at the crusher plant is remotely controlled by the loader operator. Arrival of the cars at the bin automatically slows down the locomotive and unloads the drop bottom cars. When the cars are empty, the locomotive automatically returns to the loading machine where it stops in readiness for the next load.

One new component was necessary for this system. The standard magnetic limit switch cannot be expected to position heavy equipment to very close tolerance. To provide the accurate centering required for a pusher machine, a new type of centering switch was developed. This has not yet been used under regular field conditions, but preliminary tests indicate a positioning accuracy of $\pm\frac{1}{2}$ in., with adjustment for still greater precision if desired. This centering scheme will be applicable to existing pushers and door machines, and should reduce wear and maintenance.

The battery described, which was planned for automatic operation, will require a force of nine men.

It would seem that this suggests several possibilities for by-product coke plants. For example, why should not automatic and remote control be applied to larry cars in these plants? In this operation, the automatic sequence would be: (1) spotting the larry car under the coal bunker; (2) filling the car with the proper amount of coal either by weight or volume and (3) moving to the oven which is to be charged. Lids would be removed and spouts dropped, with the larry car waiting until the pusher is in position and the pusher operator, by remote control, starts the charging operation.

The leveling operation can be programmed, so that the leveling bar will always make the same number of passes. This should assure a more uniform top surface in all ovens and also lessen the possibility of "packing" due to excessive leveling. Programmed leveling can be provided independently, without respect to other automation. If desired, it can be interlocked with the charging operation.

There is no engineering reason why the pusher and the door machine cannot be controlled automatically or remotely, or, in fact, why all moving equipment cannot be operated from a single pulpit or platform. The means are available if the need exists.

Many systems can be developed which will increase the efficiency of any operation where coal can be detected in bins or hoppers, and the indications used as signals to control both the conveyors that feed the bins and those that empty them. It is possible, for example, to detect the amount of coal as it arrives on plant property, to interlock the conveyor system that transports the coal, and, after all processing, to automatically provide the desired amount to the bunkers at the coke battery. Local control and detecting devices for each phase of this operation are already in use. All that is necessary is: gather this control and information to a central point; make some detection and control relationships automatic; and, probably, leave the others to the discretion of an operator.

Another operation which might well be made automatic is the loading of coke into cars at a screening station. A system has been devised which detects the railroad cars approaching the conveyor, measures the level of the coke as it is loaded into cars and moves the cars according to load level so that the coke will be distributed evenly in them. This system could readily be interlocked with the screening station conveyors so that as long as coke and empty cars are available the loading function will be performed automatically.

Although this article has concentrated on the handling of coal and coke, this is the only area in which further progress can be expected. Opportunities for savings may be found almost anywhere.

A recently completed monitoring and telemetering installation centralizes data from 23 reversing rooms, enabling two monitor operators to perform duties which formerly required most of the time of six heater helpers. The system employs audio tones for telemetering and circuit scanners for indication and control, thus making it possible to transmit many signals over each 2-wire circuit.

Similar systems are used in the by-product part of coke plant operation, bringing many metering functions together in a central location and permitting the transmission of control signals for any operation or process in any part of the plant.

The applications which have been described or suggested represent just a few of the things that can be done with the knowledge and equipment which is already available. What actually will be done, and when it will be done, depends on the needs and interests of the industry. ▲

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Life Dispersion Of Anti-Friction Bearings

by L. E. ROOT
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. . . . advances in bearing technology have increased bearing life range dispersion. Further advances should bring resultant life increases, but absolute fatigue life control requires a more complete understanding of the bearing fatigue phenomena . . . .

ANTI-FRICTION bearing failures fall into the two very general categories: statistically predictable failures and nonpredictable failures. Statistically predictable failures will result when bearings are selected, utilized and maintained in a manner suggested by the manufacturer; while nonpredictable failures will be either directly or indirectly due to man's frailties. Clearly, nonpredictable failures must not be deemed nonpreventable failures, for over-all education, coupled with a willingness to take nothing for granted, will reduce man's frailties in the realm of anti-friction bearing manufacture and usage. These frailties are manifest by: (1) an initially poor quality bearing to start with; (2) improper storage of the bearing by the user prior to installation; (3) incorrect mounting, whether intentional or not, with its co-partner damage-in-mounting; (4) improper or inadequate bearing lubrication; (5) improper maintainance; (6) misjudgment in the determination of forces (i.e., bearing loads) and/or paying little heed to other operating conditions which results in improper initial selection of size and/or type of anti-friction bearing and (7) willful misuse of the bearing above and beyond the alleged use; such as overloading, speed-up and exposure to known harmful environments.

Naturally, everyone would like to have all anti-friction bearing failures fall in the category of predictable failures, in general, and the manufacturers would like these failures to be of the "wear-out" type. Wear-out, in the jargon of the new science of reliability, means simply failure caused by aging and fatigue (no connotation here to bearing metallic wear, which is manifest by a macro-change in a dimension) which is a progressive reduction of product capability until the bearing is finally degraded beyond its point of usefulness. Wear-out in bearings cannot be prevented, which is the same as saying that an anti-friction bearing does not possess an endurance limit in the same sense that most people are familiar with: the fatigue limit as determined by tests in reversed bending, reversed torsion, etc. However, wear-out in bearings may often be postponed by proper preventive maintenance.

Practically, not all, or even a large percentage of, anti-friction bearing failures are statistically predictable, but, rather, too many bearing failures are of the nonpredictable variety. The nonpredictable bearing failures most frequently are the direct result of one or more of (in the terminology of the reliability engineer): (1) infant mortality; (2) constant-hazard mortality and (3) misuse beyond intended purpose. These terms may be elaborated on for the purpose of clarity. Infant mortality (sometimes referred to as a birth defect) can be thought of as the failure of a bearing during its first use and is usually the result of faulty material and/or manufacturing errors which get by ordinary inspection procedures (properly designed bearings of reputable manufacturers have low incidence of infant mortality). Constant-hazard mortality, which may occur early or late in the bearing usage, can be thought of as that accidental failure which is entirely unpredictable and will result directly from: careless bearing handling, improper assembly in an application, failure to provide lubrication which is free from mechanical (loose chips, etc.) and/or chemical (free sulphur, etc.) contamination and an endless list of other improper operational characteristics. Misuse beyond intended purpose needs no further clarification.

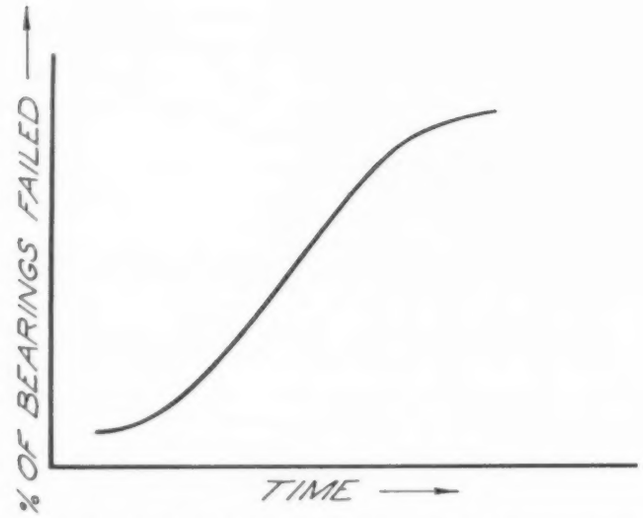


Figure 1 — Bearing failure rate is a plot of the percentage of bearings failing in a time interval.

Therefore, it must be acknowledged that one may have both statistically predictable and nonpredictable bearing failures occurring in any study of anti-friction bearing life dispersion, whether that study comprises the more difficult job of a survey of field service life of an anti-friction bearing application, or merely comprises a straight-forward analysis of bearing life as determined in the physical testing laboratory of a bearing manufacturer or a research group.

To better understand bearing life dispersion one must be acquainted with the concept of the bearing "failure rate." The bearing failure rate may be defined as the percentage of bearings failing in a given time interval, plotted as a function of time. Graphically this may be represented by Figure 1.

The extreme lower portion of the curve of Figure 1 depicts what is termed infant mortality. It may be stated that in the past only the bearing manufacturer was concerned about infant mortality; this usually represented some aspect of faulty material and/or substandard manufacturing and was undesirable merely from the standpoint of causing embarrassment to the manufacturer and in incurring unforeseen additional expense for replacement of the bearing to the irate customer. Again in the past, the customer usually desired a reasonably good mortality for the majority of the bearings being used: thus, if the bearing user observed that 50 per cent of his units had no bearing failures before other machine element trouble (failure) developed in his application, then he was satisfied as far as bearing performance was concerned. The customer or user was not too concerned over low-life bearing failures, because they constituted only a small percentage of his application headaches when considering his over-all product malfunctions.

The era of complacency is past; today all has changed. The bearing manufacturer is still vitally concerned about infant mortality, but where in the past the 10-per cent failure point was the focus of attention, now the bearing maker has had to readjust his sights to the 5-per cent (or even lower) failure point. Without a doubt the greatest impetus in this crusade on infant mortality is being supplied by the bearing user for he is now tremendously interested in this concept and is concerned over its consequences. The customer is no longer smugly satisfied with simply a reasonably good average (median) life, but he is now aware that he needs to know some sort of "minimum" life that may be expected. Toward this end it has become common practice for a bearing user to specify on his inquiry for an anti-friction bearing that a given bearing, under known operating conditions, shall have a guaranteed minimum life of a specified amount. Through the efforts of the Anti-Friction Bearing Manufacturers' Assn. (AFBMA) in close cooperation with the American Standards Assn. (ASA) a standard of criteria of minimum life has been established and is found in a published ASA standard ("Method of Evaluating Load Ratings for Ball and Roller Bearings." ASA Standard B3.11-1959, American Standards Assn., Inc., New York, N. Y.). In the nomenclature of these latter groups minimum life is called the bearing rating life, and represents that life associated with a failure rate of ten per cent (90 per cent of a large group will survive beyond the rating life).

It is of some interest to examine just what has brought about this enlightenment, this heightened interest on the part of the bearing user in regard to minimum life. It has evolved gradually over many years and is due to many factors. However, on the surface the immediate causes seem to be a product of the times, or perhaps, more accurately, a partner-in-hand of rapidly expanding technology. The bearing user must provide in his application: economy of manufacture, which implies that the smallest possible bearing, consistent with basic required strength, be used; and a high degree of assurance that human life and/or expensive material will not be endangered, such as in aircraft, space vehicles or an industrial application where the man-machine combination must be preserved for continued usefulness.

As more people concern themselves with anti-friction bearing minimum life, an understanding of bearing failure rate becomes essential. If bearing life data is available (obtained from laboratory tests or accumulated from field-service information) one may construct a cumulative plot of the results and draw a curve which will graphically illustrate the bearing failure rate. Table I lists hypothetical bearing life data for a group of ten sample bearings, and Figure 2 is the plot of this data on rectangular co-ordinate graph paper. The low sample number (ten) is selected to minimize the work covering the analysis at this point.

TABLE I

Sample	Bearing life†	Assigned median rank, per cent[1]*
1	22	35.6
2	52	74.1
3	22	45.2
4	3	6.7
5	32	64.4
6	12	16.3
7	90	93.3
8	28	54.8
9	60	83.7
10	16	25.9

† Expressed in millions, of inner ring revolutions.

* Numbers in parentheses refer to Bibliography at end of article.

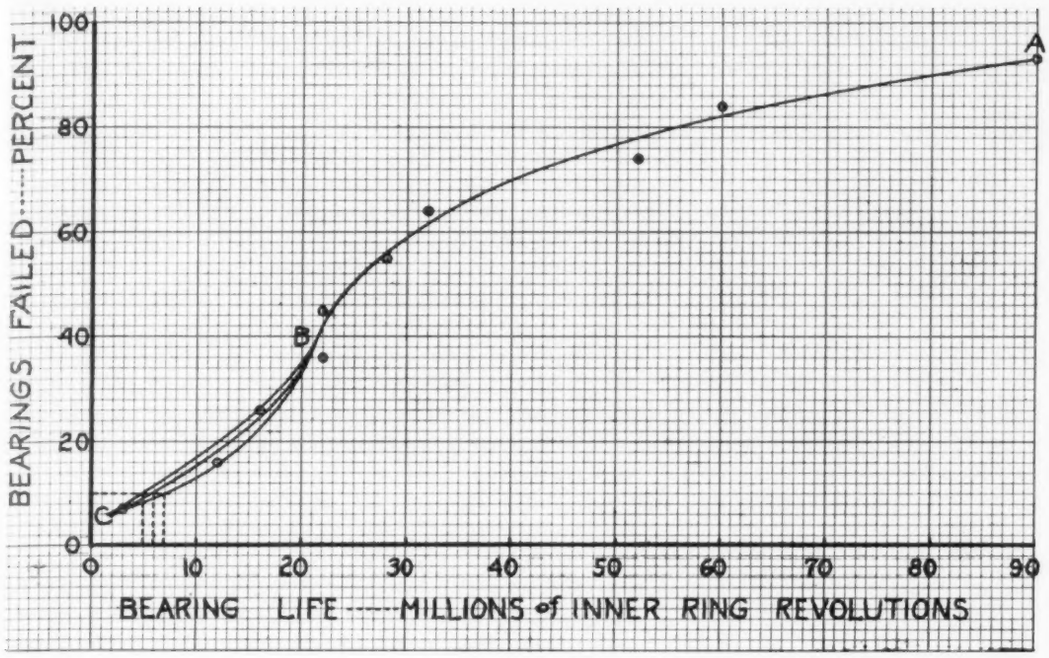
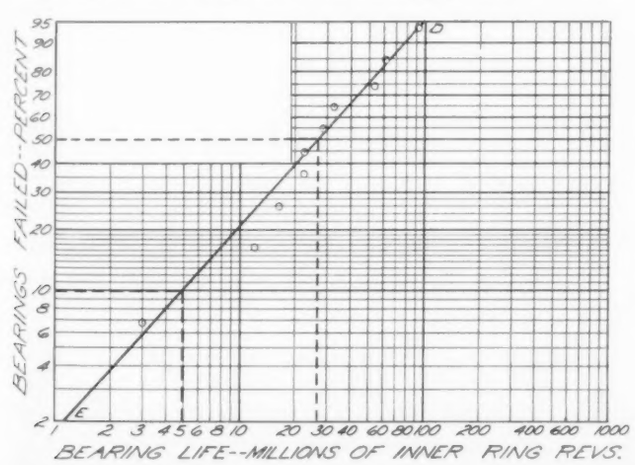


Figure 2 — The line which represents early failures (C to B) is not a distinct path. This is the area of greatest interest.

In Figure 2 the failure rate is clearly defined over a portion of the curve; namely, from point A to point B, for this is about the only continuous line that could be drawn which well represents the plotted data. However, the failure rate toward the lower portion of the curve, from point B to point C, is not as clearly defined, for one could have three possible paths in going from point B to point C. It is all the more unfortunate that the failure rate is not clearly defined in this lower portion of the curve, for it is there (at the 10-per cent failure point) that one is most interested in having an accurate determination of bearing life. The minimum life, as indicated by the dotted lines in Figure 2, is either 5, 6 or 7 x 10^6 revolutions, depending on which curve is selected for the B to C path. Engineering analysis of curves with "tails," such as in Figure 2, is always difficult. If it would be possible to straighten out such a curve without excluding certain data, then more useful engineering forecasts could be made. Undoubtedly, many share the opinion of the late C. F. Kettering relative to the plotting of data on special paper; namely, graph paper with logarithmic co-ordinates. Mr. Kettering said, "Only when you want to deceive to the greatest possible extent do you ever resort to that—because what you do, you plot a straight line to a crooked base, and you do not show it as being crooked." However, it is surely true that a logarithmic-type co-ordinate system for plotting is an established engineering tool for data analysis and has gained acceptance through the years. Thus, if the data from Table I is plotted on special Weibull probability paper (which actually is a log-log scale along the ordinate and a log scale along the abscissa) the curved distribution line A-B-C of Figure 2 is resolved into the straight distribution line D-E of Figure 3. Although the data from which this plot was constructed was a hypothetical example, actual bearing life test results plotted on the special Weibull probability paper will ordinarily always have a straight line as truly representative of the bearing failure rate.

Figure 3 — The use of logarithmic co-ordinate paper converts the curve of Figure 2 into a straight line.



Two of the more interesting points on this plot are the 10-per cent failure and the 50-per cent failure locations; these representing the rating life (termed B-10 or minimum life) and the median life respectively. The relation between these points is important, for it indicates: the fraction of a large group of bearings that will actually have a short life. For the plot appearing in Figure 3, the bearing life for 10-per cent failure is one fifth of the bearing life for 50-per cent failure, which means that the rating life is one fifth of the median life. It then follows that the slope of the straight line of Figure 3 is the all important factor in relating rating life to median life. The straight line of Figure 3 is at an angle of approximately 45 degrees from the co-ordinates; actually, the geometric slope is equal to 1.11.

Early in the history of American anti-friction bearing manufacture, from 1900 to 1925, it was not uncommon to observe a very large range of bearing life, this range actually being of the order of 1000 to 1. The line representing such a life distribution is shown as line A-A on the plot appearing in Figure 4. The slope of this line is equal to 0.72 and the rating life (10-per cent failure) is

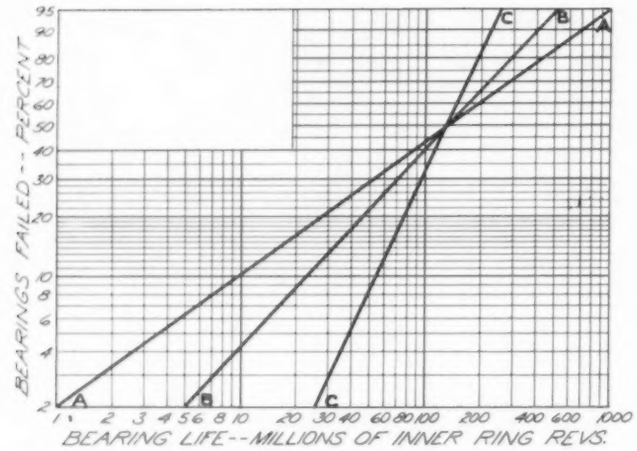


Figure 4 — Bearing life plots have changed due to reductions in the range of bearing life and improved bearing life.

approximately 1/13 of the median life (50-per cent failure). During the period from 1925 to 1950, new manufacturing methods and improved inspection techniques reduced the range of bearing life; the observed range during the second quarter of the century was of the order of 100 to 1. The line representing such a life distribution is shown as line B-B in Figure 4. The slope of this line is equal to 1.08, and the rating life is approximately one fifth of the median life. One can observe, then, that the bearing manufacturer has come a long way in providing the nation's industrial complex with a vastly improved product, for in the span of some 50 years there has resulted a 136-per cent increase in anti-friction bearing rating life. The significance of this is not that the bearing user now has to replace bearings less frequently, but, rather that there has been affected a true increase in the permissible load carrying capacity of the bearing. For the 136-per cent increase in rating life as indicated above there results a 31-per cent (approximately average value for all types of anti-friction bearings) increase in capacity. The practical aspect of this is that the machine designer may now utilize a smaller bearing than he could have in the early 1900's. This has also had an impact on bearing manufacturers as indicated by the steady trend through the years away from the thick sectioned rings, characteristic of the heavy series of bearings, toward the thinner sectioned rings, characteristic of the light series of bearings.

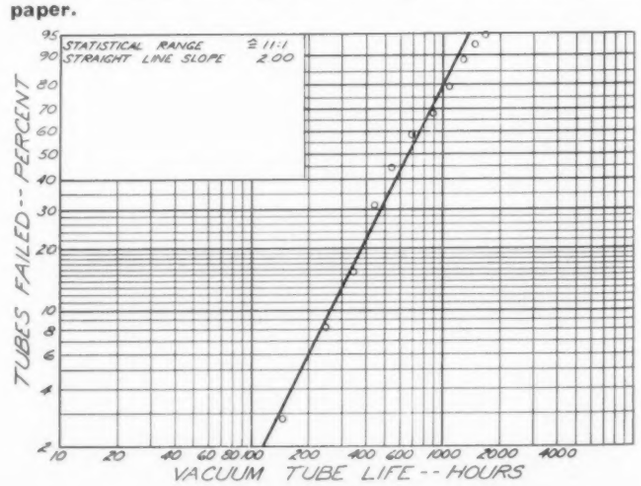
What is foreseen for the third and fourth quarters of the twentieth century with regard to improved anti-friction bearing life? What will be the characteristic of the bearing failure rate, and what new line (Figure 4) will represent the bearing life distribution in the future? Perhaps the bearing manufacturers can realize, consistently, an observed range of bearing life of the order of ten to one. The line representing such a life distribution is shown as line C-C in Figure 4. The slope of this line is equal to 2.16 and the rating life (10-per cent failure) is between 1/2 and 1/3 of the median life (50-per cent failure). If this goal can be attained, there will result another 136-per cent increase in anti-friction bearing rating life, which means another 31-per cent increase in bearing capacity. The desirability of having a bearing life distribution as indicated by line C-C (Figure 4) is self-evident. In addition to the life or capacity increase indicated, there is also an accompanying improvement in reliability of performance; that is, the probability of always attaining the bearing rating life in actual service is much better for line C-C than for line B-B.

Is it probable that an improvement in bearing life can be achieved in the near future? Everything points toward an affirmative answer! The steel producer has provided the bearing manufacturer with a cleaner, more homogeneous product through newly-developed processes: vacuum melting, consumable electrode melting, etc. The metallurgists and engineers in the steel industry have developed a superior class of steels adaptable to bearing usage (M1, M10, M50, etc.) which have their greatest benefits when bearings are subjected to very high operating temperatures. Machine tool builders have improved the machines used by the bearing manufacturer so that now, more than ever before, every given bearing part produced is identical with any other produced. Bearing makers themselves have improved manufacturing techniques, instigated more comprehensive quality control in heat-treatment and expanded the role of inspection throughout the entire cycle of manufacture. New and sophisticated inspection instruments are gaining wider acceptance throughout the bearing industry, and the time may be quite near when an infant mortality directly traceable to an initially faulty bearing will be a memory.

The factory engineer and the man concerned with mechanical and/or electrical shop supervision has a tremendous responsibility in this crusade toward improvement in anti-friction bearing life. These men are the connecting links between the bearing manufacturer and the ultimate user of the product. Only to the extent that these men carry out rigorous supervision, regarding bearing handling, assembly into finished product and provision for adequate lubrication, will early bearing failures be prevented. If these men adhere to a program of continual surveillance of anti-friction bearings from the time the bearing is unwrapped until the bearing is assembled into the end product, then the time may come when a bearing failure of the constant-hazard type will disappear from the scene.

A possible goal for an improved life dispersion characteristic for anti-friction bearings as expressed by

Figure 5 — The failure rate for other manufactured items also approaches a straight line on logarithmic co-ordinate paper.



a more favorable bearing failure rate was suggested which would result in a smaller total range for bearing lives and a steeper slope of the failure distribution line in the Weibull failure plot. In particular, the goal chosen was for a ten-to-one range of life and a slope value of 2.16. It is not enough to be content with this arbitrarily selected value; effort should be directed toward greater improvement, with revised goals of, perhaps, eight to one, then six to one and so forth for the life range. There naturally arises the question, "What is the probable limit for improvement in life dispersion of anti-friction bearings?" If it were possible to achieve the ideal pattern for life dispersion then there would actually be no dispersion at all; all failures would occur after the same number of revolutions, the figure expressing range of life would be one to one, and the Weibull plot slope would be infinite (the failure distribution line would be vertical).

It probably will not be possible to achieve the ultimate of desired life dispersion; what then is the foreseeable limit that may be expected, considering the practical aspects of anti-friction bearing manufacture? Baughman[2] indicates fatigue life ranges of about four to one for cylindrical specimens (not bearings) of M10 tool steel run in a special rolling contact test rig; and average fatigue life ranges of 15 to 1 for specimens of M1 tool steel, similarly run. Baughman[2] also plots data obtained by other investigators relative to fatigue life of two sets of complete bearings made from M10 (air melted) steel, and the statistical fatigue life range was apparently a surprisingly low value: 3.6 to 1 for one set and 4.8 to 1 for the other set.

It is of interest to note the dispersion characteristics of some other physical phenomena. Figure 5 shows a plot of observed and recorded physical data plotted on the same special (Weibull) probability paper that has been previously used. It may be seen that, as in the case for plots of bearing failure, the distribution line best representing the failure rate appears as a straight line on this special probability paper. No attempt will be made to interpret, philosophically, the meanings of this latter plot as it might bear on the plots of anti-friction bearing failure. The plot of Figure 5 is included for the purpose of illustrating how a statistical treatment of nonbearing-related data compares with the same statistical treatment of anti-friction bearing failures.

SUMMARY

Any large group of anti-friction bearing failures exhibit some spread, or range of values, for life. This is referred to as the bearing life dispersion, and it is graphically illustrated by the characteristic of the bearing failure-rate distribution line shown on a statistical plot of bearing failure data.

It is desirable from the standpoint of the user and the manufacturer to have the life dispersion of anti-friction bearings as small as possible. To achieve this, bearing manufacturers have a duty to seek continued improvement of product, and bearing users have the responsibility to exercise every precaution regarding correct utilization and maintenance of anti-friction bearings.

If advances in bearing technology continue at a pace consistent with that exhibited over the past 50 years, and if those people in engineering and shop supervisory capacities carry out an enlightened program of correct bearing application and usage, then it cannot help but follow that in the next 50 years a significant reduction in anti-friction bearing life dispersion will be realized.

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Discussion

PRESENTED BY

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F. W. Wellons: One can anticipate improvements in bearing load carrying capacity along with some limited reduction in life dispersion within a given group of bearings, but absolute control of the fatigue life for rolling contact bearings will require full understanding of the fatigue phenomena and the mechanism of its progress.

In the hypothetical example of bearing life dispersion offered by the author, he has assumed only ten bearing samples. Normal laboratory practice is to run a test group of at least 30 bearings which are specially selected and manufactured for absolute similarity of material and geometry. Under these conditions, there will be several fatigue failures at lives below the 90-per cent point on the Weibull plot. However, there is no known metallurgical or physical procedure that will identify these short life bearings prior to test. In addition to the careful manufacture of these test bearings, the bars from which the bearing rings are cut should be selected to represent a random position within the as-cast ingot and the rings should be cut from the selected bars to assure statistical equality. The test rigs are precision machines, and the test operation is constantly supervised by experienced personnel. The point to be made is that the early failures that show up in every endurance test of rolling contact bearings cannot be attributed to

known variations within the bearings themselves, nor can the early failures be blamed on inadequate mounting or careless testing. In fact, if the test results show that the failures are effected by these extraneous factors, the complete test is thrown out.

Even today it is possible to furnish a group of bearings, which would have uniform lives, that would give a vertical plot on a Weibull curve; however, these bearings would be uniformly bad because of faulty material, heat treatment or manufacture so that all bearings failed almost instantaneously in the application. On the other hand, numerous endurance tests have been made with particularly good lots of bearings without reducing dispersion. For example, in one test using vacuum-melted M50 steel, the test results showed a load carrying capacity that was 144 per cent of the present-day catalog rating yet the Weibull slope and the difference between the 90 and 50-per cent lives was essentially the same as obtained with conventional bearings of air-melted material. In other words, there was a significant increase in load carrying capacity through a change in material, yet there was no significant improvement in the dispersion among the lives of the some 30 individual test bearings.

C. A. Moyer: When the author talks of predictable failures for bearings, it must be made clear that he does not mean one can actually predict the life of a bearing within the machine complex, but that one can only estimate the odds that this bearing will survive the previously decided lifetime.

For instance, the line drawn on the Weibull plot in Figure 3 is only an estimate of the life curve for the larger group or population from which the hypothetical ten bearings shown in Table I were drawn. Population is usually defined as all the bearings of one size that would have some common characteristic such as all bearings manufactured in one year or all identical bearings that have gone and will go into one position of a machine. This estimate of the life curve is all one ever has since only small samples from any population can be tested in order to predict what life other identical bearings under the same loading will provide.

Thus the prediction from Figure 3 that ten per cent of the bearings will fail by 5,000,000 inner ring revolutions is only an estimate, and one should not be surprised if another group of ten bearings from the same source shows other than one failure by this lifetime. Actually the methods used by Johnson[1] provide one means of calculating the confidence limits for the 10-per cent failure estimate from ten failures. Based on the estimate and the geometric slope of the Weibull line, there is a 90-per cent probability that the true mean will fall within a band from about 1,000,000 to 25,000,000 revolutions. Another way of saying this is that there is one chance in ten that the true population 10 per-cent failure value is actually outside the estimated band.

No doubt the author is aware of this unpredictability attached to bearing life dispersion, but it was felt that it should be emphasized, because there are times when bearing users wish to life test small samples of bearings from a purchased lot, perhaps as a quality check. They unfortunately may not realize the possibility of misinterpreting their results based on such a limited number of tests. A reputable bearing manufacturer will have a background of thousands of laboratory bearing life tests and comparable accumulations of service data so that his estimates of a particular failure point have considerably more reliability. It is largely this background of testing and experience that allows a reputable bearing manufacturer to recommend a bearing for his customer's particular application with full assurance that the bearing will provide the minimum life required as the author suggests.

L. E. Root: F. W. Wellons suggests that there will be random early fatigue failures of anti-friction bearings, notwithstanding the contemplated continued improvement in bearing manufacture and in responsible application practice, and his point is well taken, for the very nature of anti-friction bearing fatigue, being based on mathematical statistics, bespeaks the constant possibility of the early fatigue crack opening up, with ensuing bearing failure. Perhaps the time when one may expect no random early fatigue failure will be that time when a full understanding of the fatigue phenomena is available. Presently an industry-wide basic research study along these very lines is already under way, under the auspices of the American Society of Mechanical Engineers.

It is probably true that mounted radial internal clearance values for individual bearings in a large group under test have not been given their due. In order to have mounted radial internal clearance identical for all test bearings of a large group, all bearings should have the same unmounted internal clearance, all bearing bore-to-shaft press fits should be identical (total possible range as well as mean values) all bearing OD-to-housing fits should be identical and all test machine setups utilized for the same test should possess the same heat-transfer characteristics. It is evident that it would be unlikely that all of these requirements could be met. Investigations conducted by the author's company indicate dependence of bearing fatigue life on the mounted radial internal clearance:

1. For a mounted internal radial clearance equal to twice that clearance associated with normally expected bearing life (as forecast from the standard life equation) the resultant actual life will be 72 per cent of the normally expected life.

2. For a mounted internal radial clearance equal to three times that clearance associated with normally expected bearing life, the resultant actual life will be only 56 per cent of the normally expected life.

Mr. Wellons commented that a group of bearings can be made to give uniformly short lives (and hence yield a vertical plot on a Weibull plot) but that these bearings would be uniformly bad. It does not follow that the concept of uniform life, with a vertical Weibull plot, is not desirable. In the introduction of a booklet produced by the ASME research dept. ("Research on the Mechanism of Contact Fatigue") outlining aims of the program of the ASME Research Committee on Contact Fatigue of Rolling Elements, it is stated that: "In this age of supersonic aircraft, missiles and space vehicles, reliability approaching 100 per cent is necessarily required. The functioning of loaded parts in contact cannot be calculated on the basis of some percentage possibly failing permaturely. A definite, reliable performance is mandatory if the craft is to be successful."

Clearly, what would be desirable would be to have a

large group of bearings made to give uniformly long lives, and it is felt that this goal will be approached during the next 25 to 50 years.

The narrow concept of the prediction of the life of any single bearing within a machine complex vs the broader concept of the use of statistical theory to give a good estimate, with a narrow "confidence band," of life is significant. One would have to speak about bearing rating life (minimum life) even with improved indicated Weibull plot slopes, in terms of a forecast and not as an exact prediction. Weather forecasts, except in some regions of highly variable ambient conditions, are generally very reliable, yet often some particular, usually highly localized, area of a region covered in a weather forecast will not exhibit the conditions covered by the general forecast.

Mr. Moyer's elaboration of other material presented in L. G. Johnson's article[1] is most informative. He noted that for a sample lot of ten bearing fatigue failures, and considering calculated confidence limits, the indicated 10-per cent failure value of 5,000,000 revolutions (Figure 3) actually could vary from 1,000,000 to 25,000,000 revolutions. Expanding on this idea, and examining what actual range of 10-per cent failure values might be expected for sample lots of 30 bearing fatigue failures, attention should be called to reported results in ACTA Polytechnica 96.[3] Here, ten test series of 30 bearings each are listed with associated values of the geometric slope of their respective Weibull plots (e-values); series shown include tapered, cylindrical and spherical roller bearings of a variety of basic sizes. The observed range of e-values is 0.7 minimum to 1.4 maximum. If it can be assumed that for some other test series of one single type and size bearing this same e-value range would exist, one may then examine, through Weibull plots, what the range means in regard to a range of 10-per cent failure values, this being a confidence limit of sorts. Since it is probable that all of the tests on any one size bearing will yield identical median (50-per cent failure) lives, it then follows that over a range of slopes (e-values) from 0.7 to 1.4 the 10-per cent failure value could exhibit from a 60-per cent decrease to a 40-per cent increase from that as indicated with a slope equal to 1.11 (presently accepted mean slope value). Thus, for the particular problem referred to above (Figure 3) if the sample lot had been chosen at 30 and the same Weibull plot resulted, then the apparent 10-per cent failure value of 5,000,000 revolutions would have a possible range, for other sample lots of 30, of from 1,850,000 to 7,100,000 revolutions.

Clearly, what is inferred by the above is that not only are steeper slopes (higher e-values) of the Weibull plot desirable from a standpoint of reducing the total range (1 to 99 per cent) of bearing failures but with the steeper slopes will come narrower confidence limits. The possible range of values of the 10-per cent failure point will be much smaller when it is possible to produce bearings exhibiting steep Weibull slopes. ▲

Available Translations

As a service to readers of the *Iron and Steel Engineer* a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those of primary interest to the American steel plant operator. The papers may be obtained from the British Iron and Steel Industry Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W. 1, England. All correspondence concerning price, ordering and so forth should be directed to that address.

1529 WENGER, E.: "The Determination of the Frictional Losses on Roll Neck Journals When Water is Used as a Coolant and Lubricant," *Stahl Eisen*, 1959, 79, Sept. 3, pp. 1263–1268. (A method is described in which the frictional losses of open roll neck journals are estimated with satisfactory accuracy from the thermal energy picked up by the cooling water. The sources of error which would impair the results are enumerated and it is shown that with sufficient care these can be eliminated. Owing to the permanently changing load on the journals no friction coefficient could be determined from the results of the experiments.) (*J.I.S.I.* abstract)

1731 HART, H.: "Continuous Thickness Measurement During Rolling by Means of Radiation," *Z. Metallk.*, 1960, 51, Feb., pp. 120–131. (An illustrated review of current practice and equipment used for the continuous thickness measurement in rolling mills by B- and Y-radiation.) (*J.I.S.I.* abstract)

1827 PROBSTL, G. H.: "Radioactive Marking Technique for Investigating Metallurgical Processes in Steelworks," *Stahl Eisen*, 1960, 80, June 23, pp. 863–877. (A lecture delivered to the Verein Deutscher Eisenhuttenleute dealing with the whole field of application of radioisotopes in steelworks. This review is well illustrated and supplemented by 119 references and followed by a discussion.) (*J.I.S.I.* abstract)

BISI 1963 WILHELM, E.: "Evaluation of Replies to a Questionnaire on the Life of Rolls in Special Steel Rolling Mills," *Stahl Eisen*, 1960, 80, Sept. 1, 1207–1211. (Stressing of the rolls under the particular conditions of special steel rolling mills. Method of inquiry into the life of rolls in blooming, billet and sheet bar rolling mills. Difficulties resulting from inadequate original records. Significance of the length of material rolled. Development of a formula for determining the "quality" of a roll. Evaluating the replies. Confirmation of the results by a works trial with spheroidal graphite cast-iron rolls. Conclusions for future comparisons of performance.) (Author's summary.)

2109 SCHULZ, G.: "The Importance of Noise Measurement for the Effective Abatement of Noise Nuisance in the Iron and Steel Industry," *Stahl Eisen*, 1961, Feb. 16, pp. 220–228.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Friday, December 8, 1961
Christmas Dinner and Dance
Social Hour 6:30 P.M.
Dinner 7:30 P.M.
Dancing 9:00 P.M. to 12 M.
Redmont Hotel, Birmingham, Ala.

BUFFALO SECTION

Saturday, December 9, 1961
Christmas Dinner and Dance
Hotel Statler, Buffalo, N. Y.

CANTON SECTION

Saturday, December 9, 1961
Christmas Dinner and Dance
Onesta Hotel, Canton, Ohio

CHICAGO SECTION

Saturday, December 2, 1961
Christmas Dinner and Dance
Great Hall, Pick-Congress Hotel, Chicago, Ill.

CLEVELAND SECTION

Saturday, December 2, 1961
Christmas Party
Cleveland Engineering & Scientific Center
3100 Chester Avenue, Cleveland, Ohio

COLORADO SECTION

Tuesday, December 19, 1961
Christmas Dinner Dance—7:00 P.M.
Minnequa University Club, Pueblo, Colo.

DETROIT SECTION

Saturday, December 9, 1961
Christmas Dinner and Dance
Detroit Yacht Club, Detroit, Mich.

LOS ANGELES SECTION

Saturday, December 2, 1961
Christmas Party
Social Hour 6:30 P.M.
Dinner and Dance 8:00 P.M.
Statler Hilton Hotel, Los Angeles, Calif.

PHILADELPHIA SECTION

Saturday, December 2, 1961—Dinner 6:00 P.M.
Metting 7:00 P.M.

"**Recent Improvements in the No. 1 Open Hearth at Fairless Works,**" by C. J. Burch, Supervisor Design, Open Hearth, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"**Five Years' Progress in Sinter Plant Design,**" by G. M. Sharer, Supervisor Design, General Facilities, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Saturday, December 16, 1961
Christmas Dinner and Dance
Dinner 8:00 P.M.
Dance 9:00 P.M.
Penn-Sheraton Hotel, Pittsburgh, Pa.

ST. LOUIS SECTION

Saturday, December 2, 1961
Christmas Dinner Dance
Social Hour 6:30 P.M.
Dinner 7:00 P.M.
Dancing 9:00 P.M. to 1:00 A.M.
Stratford Hotel, Alton, Ill.

SAN FRANCISCO SECTION

Saturday, December 9, 1961
Christmas Party
Diablo Country Club, Danville, Calif.

UTAH SECTION

Friday, December 1, 1961
Christmas Party
Salt Lake City Country Club, Salt Lake City, Utah

YOUNGSTOWN SECTION

Saturday, December 2, 1961
Christmas Party
Pick-Ohio Hotel, Youngstown, Ohio

factors involved in the Selection of Electrical Drive Ratings for metal rolling mills

by ALONZO F. KENYON, Advisory Engineer,
Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

. . . . graphical representations of the capabilities of a proposed mill, considering all limiting parameters, furnish substantial information which can be used to determine the mill drive requirements and develop the rolling schedule . . . .

THE natural first step in the selection of the electrical drive ratings for any proposed new rolling mill is to realistically establish the range of schedules to be rolled on the mill within the immediate and forseeable future. Then detailed power calculations for the limiting schedules, to estimate the rolling loads which the motor drives will have to carry, must be made.

Rolling mill operators, mill machinery builders and electrical manufacturers have accumulated files of load test data for the rolling of different sizes and grades of steel and nonferrous metals in different types of rolling mills, and methods of calculation have been developed to reduce this data to per unit (pu) values so that it may be interpolated and extrapolated to predict the loads to be expected in the operation of a proposed new mill. Much of this test data, methods of calculation, etc., have been made available by papers presented at meetings of the AISE and published in *Iron and Steel Engineer* and AISE Proceedings (The Bibliography lists the more significant of these earlier publications).

This article refers only incidentally to the detail load calculations for particular schedules on a proposed mill, but will show some ways in which the data from these detail calculations may form the basis for extensive analysis of the effects of the many variables over the whole range of schedules to be rolled on the mill.

TANDEM COLD REDUCTION STRIP MILL

A typical tandem cold reduction strip mill is used as an example. It is assumed that the mill under consideration is a 4-stand, 66-in. wide mill. The mill is to produce strip ranging from 24 to 60 in. wide. Normal strip thicknesses will be between 0.015 and 0.060 in., but some strip will be rolled to 0.010 in. and some will finish at 0.125 in. Starting hot bands may range from 0.072 in. for rolling to the lightest finished strip, up to perhaps 0.1875 in. for rolling to the heaviest finished strip. Maximum rated mill speed has been tentatively selected at about 4000 fpm.

Also, it is assumed that detail calculations have been made for several typical rolling schedules, covering the range of strip width, starting and finished thickness, reductions per pass, tensions between stands, arbitrarily assumed speeds, etc. At this point it may be noted that Fortran programs have been written to enable many such calculations to be made very quickly by a high-speed computer. The computer may be used to calculate the operation for various arbitrarily assumed schedules; or more usefully, limiting parameters may be set into the computer program to develop schedules to limit the loads on the various drives to specified values, divide the total load among the various drives in some specified ratio, keep speeds within the speed cone, limit maximum drafts, maintain unit or total tensions between stands, etc.

From these detail schedule calculations and by comparison with the drive ratings which have been installed on other similar mills, mill stand and reel drives totaling 22,000 hp have been tentatively selected. Now it is in order to observe the mill operating capability over the expected range of product sizes with this drive capacity. It is unlikely on any particular order that all of the stand drives will be equally loaded in proportion to their ratings, and the reel drive may be operating at reduced voltage and hence less than its nominal horsepower rating; therefore, with 22,000-hp total rated drive capacity, one may reasonably expect about 20,000-hp total available under usual operating conditions.

Figure 1 shows several interesting fundamental relations. The curve at the bottom is the familiar hp-hr per ton (HHT) curve showing the total unit energy required to cold reduce 0.095-in. thick starting hot band to various finished strip thickness. Near the

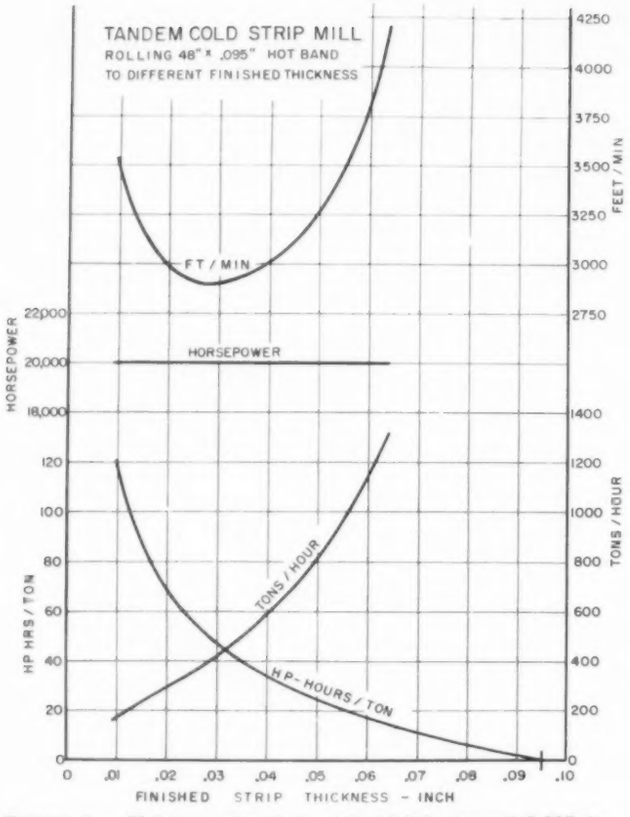

Figure 1 — Using a starting strip thickness of 0.095 in., several fundamental production curves have been plotted.

center of the chart, the horizontal horsepower curve indicates the continuously available 20,000-hp total drive capacity, and the tons per hr curve, derived as the quotient of 20,000 hp divided by the HHT, is the rolling rate to impose this total load. Now the delivery speed corresponding to this rolling rate may be calculated by use of:

$$\text{fpm} = \frac{\text{tons per hr}}{0.1025 \times \text{width} \times \text{thickness}}$$

The fpm curve at the top of Figure 1 shows the speed at which 48-in. wide strip can be delivered to impose 20,000-hp total mill and reel load.

For small elongations, the HHT required is small, permitting large tons per hr rolling rates, and corresponding to high fpm rolling speeds. For large elongations to thin finished strip, the HHT required is large, enabling only small tons per hr rolling rates, but requiring high fpm rolling speeds to produce even small tonnage outputs. In the range from about 0.020 to 0.040-in. finished strip thickness, the increase in unit energy consumption is just about balanced by the decreased rolling rate, so that the delivery speed to impose 20,000-hp total load remains practically constant at about 2900 fpm.

Similar calculations can be made for other strip width and starting hot band thickness, and the curves on Figure 2 have been plotted to show the mill speed capability with the assumed 20,000-hp total drive capacity for the expected entire range of product sizes. In the middle of Figure 2, the same curve as shown at the top of Figure 1 has been replotted, for rolling 48 in. wide by 0.095-in. thick starting hot band, and similar curves are shown for rolling from 0.072, 0.078, 0.085, 0.109, 0.125, 0.150 and 0.1875-in. thick starting hot band. At the left of the chart there are ordinate scales for the permissible delivery speeds corresponding to 32, 40, 48 and 60-in. wide strip. Also note the light line curves showing points of equal elongation on the different speed curves.

It is felt that Figures 1 and 2 indicate one way to graphically show the results of detail schedule calculations, and indicate the effects of various combinations of strip width, starting and finished strip thickness, rolling speed, etc. This method of analysis may be useful in making proper selection of equipment during the planning and design stage of a new mill; also, it may be of further use after the mill has been installed, in scheduling the mill for most economical operation, establishing equitable incentive rates, etc.

CONTINUOUS HOT STRIP MILLS

The feature of modern hot strip mills which most greatly affects the drive ratings is the specification that the mill must be capable of producing strip in extremely heavy coils. Until a few years ago, 15,000 lb was considered a big coil, and few hot strip mills could produce coils of more than 200 to 250 lb per in. of width. Coils of 500 to 650 lb per in. are becoming commonplace, and mills now under construction and being planned will be able to produce coils of 800 to 1000 lb per in. and 60,000 to 70,000-lb total weight.

It may be noted that to finish a 900-lb per in. width coil requires starting from a 30 ft long by 9-in. thick slab, thereby requiring greater total elongation to reduce to the specified finished hot strip thickness. Thus the unit work and power requirements are increased, and to maintain reasonable reductions per pass may dictate five rather than the usual four roughing stands and seven rather than the conventional six finishing stands. Further note that a 0.072-in. thick strip will be 125 times the length of the 9-in. thick starting slab, so that a 30-ft long slab will have been elongated to a 3750-ft long strip when it is delivered to the runout tables and coilers. Even at 2500-fpm delivery speed, the time to go through each finishing stand will be 1½ min, hence the new mills to produce heavy coils must be designed for delivery speeds approaching 3000 fpm, with proportionate increase in drive capacity.

The larger slab size naturally also increases the size of the bar to be handled in the roughing mill, so that the spacing between roughing stands and between the roughing mill and finishing mill must be made sufficient to accommodate the longest bar. To partially overcome this situation, finishing mills are being designed to start with the thickest practicable bar, either by taking the heaviest practicable drafts, or on some mills by utilizing an additional finishing stand. A 30 ft long by 9-in. thick slab will product a 270 ft long by 1 in. thick or 216 ft long by 1¼-in. thick bar, requiring large roughing stand spacing and a long table between the roughing and finishing mills.

The foregoing brief comments indicate the reasons for the tremendously large individual stands and total power on these large modern hot strip mills. This trend is exemplified by an 80-in. wide mill now under

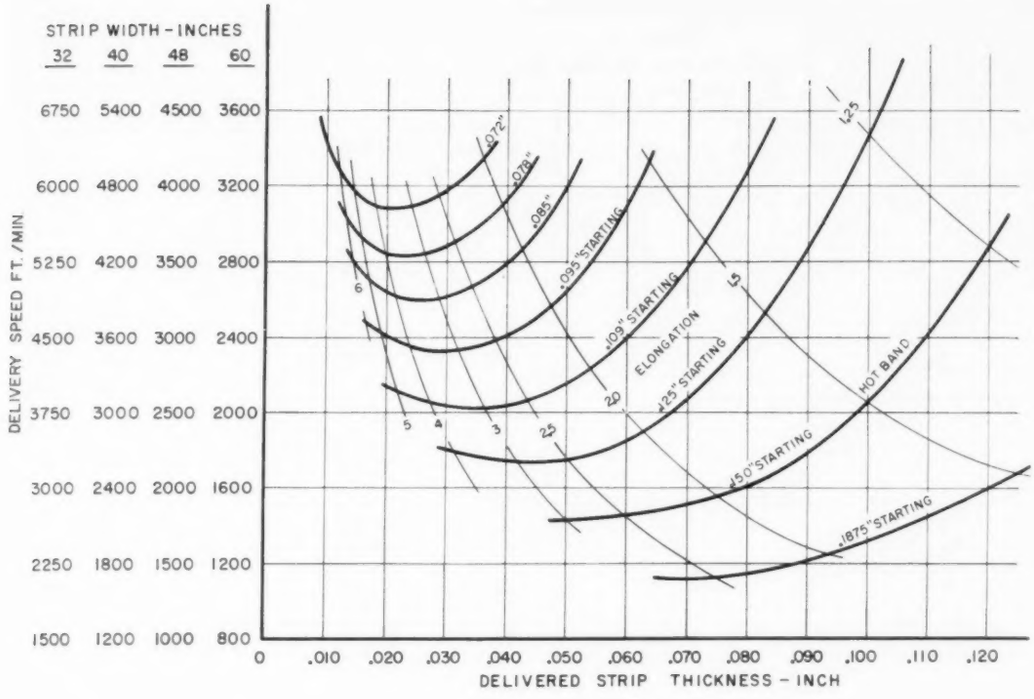

Figure 2—The curves represent delivery speeds to hold 20,000-hp total load on a 66-in., 4-stand tandem cold mill.

construction in the Detroit area, with drive ratings as listed in Table I. The five roughing stands are driven by two 5000-hp and three 10,000-hp synchronous motors, and the seven finishing stands are driven by two 7000-hp motors on stands F-1 and F-7 and five 8000-hp motors on stands F-2 to F-6. Including the auxiliary scalebreakers and edgers, the total roughing mill drive capacity is 43,500 hp and the finishing mill drive capacity is 54,500 hp, making a grand total of 98,000 hp. Maximum nominal delivery speed is 2990 fpm, and it is expected that many schedules can be rolled at 2700 to 2800 fpm. Also a similar 80-in. mill with almost identical drive ratings is in the active design stage for installation in France.

Some hot strip mills have been installed with the finishing stand drive motors designed to have more than the standard 175 per cent frequently repeated maximum load capacity to carry the expected high rolling loads. However, many mills now have slab heating furnace capacity, slab and coil handling facilities, etc., to enable sustained high hourly production rates so there are only short idle intervals between strips, and careful analysis must be made of the rms heating loads as well as the maximum peak rolling loads. In most recent cases, it has been found most economical and practicable to use drive motors of standard 175 per cent frequently repeated maximum load capacity and select the horsepower ratings so that the expected rolling loads will be within this capability, and even with these standard motors the rms heating loads rather than the maximum rolling loads may impose the limit on maximum mill output.

STUDY OF A 66-IN. HOT STRIP FINISHING MILL

A study of an assumed typical 66-in., 6-stand hot strip finishing mill illustrates what is felt to be a new approach in showing graphically the mill production capability for a range of product sizes within limiting parameters of motor maximum peak and rms loading, delivery speed, finishing mill time, slab size, division of work among stands, etc.

As the first step in the study, Table II shows the conventional detail power calculation for rolling 48 in. wide by 1.000 in. thick by 240-ft long bar (rolled from a 30 ft long by 8-in. thick slab in the preceding roughing mill) to 0.072-in. thick finished hot strip. Final delivery speed is selected at 2222 fpm so the 3333-ft long strip can be finished within 90 sec, the assumed maximum permissible rolling time. Also the drafting has been selected on the basis to impose equal 1.0 pu loads on each of stands F-1, F-2, F-3 and F-4, 0.8 pu load on F-5 and 0.5 pu load on F-6. The reductions then are 54, 44, 36, 32, 24 and 15 per cent respectively in the

TABLE I
An 80-In. Continuous Hot Strip Mill

Stand	Motor		Roll, fpm
	Hp	Type	
Edging scale-breaker	1,500	Synchronous	202
R-1	5,000	Synchronous	201
E-1	500	D-c	96/192
R-2	5,000	Synchronous	201
E-2	500	D-c	159/318
R-3	10,000	Synchronous	330
E-3	500	D-c	210/420
R-4	10,000	Synchronous	442
E-4	500	D-c	270/540
R-5	10,000	Synchronous	561
Roughing total	43,500		
Scalebreaker	500	D-c	184/368
F-1	7,000*	D-c	189/379
F-2	8,000*	D-c	314/690
F-3	8,000*	D-c	484/1067
F-4	8,000*	D-c	702/1550
F-5	8,000*	D-c	925/2060
F-6	8,000*	D-c	1310/2620
F-7	7,000*	D-c	1495/2990
Finishing total	54,500		
Combined total	98,000		

* Double Armature

TABLE II
A 66-In. Hot Strip Finishing Mill*

Pass No.	Thickness, in.	Length, ft	Per cent reduction	Fpm	Tons per hr	HHT	Rolling hp	Rolling time, sec
Slab	8.000	30	..	...	...	...	...	...
Bar	1.000	240	..	160	...	...	...	...
F-1	0.460	...	54	348	...	9.85	7,650	...
F-2	0.258	...	44	620	...	9.85	7,650	...
F-3	0.165	...	36	970	...	9.85	7,650	...
F-4	0.112	...	32	1430	...	9.85	7,650	...
F-5	0.085	...	24	1880	...	7.85	6,100	...
F-6	0.072	3333	15	2222	775	4.75	3,700	90.0
Total	...	...	..	...	...	52.00	40,400	...

* Rolling 48 in. by 1.000 in. by 240 ft -0in. bar to 0.072-in. strip.

TABLE III
A 66-In. Hot Strip Finishing Mill*

Width, in.	48	24	27.9	31.4	50.25	60	60
Length, in.							
Slab	30	30	30	30	30	30	25.1
Bar	240	240	240	240	240	240	201
Strip	3,333	3,333	3,333	3,333	3,333	3,333	2,790
Delivery speed, fpm	2,222	2,500	2,500	2,222	2,222	1,860	1,860
Tons per hr							
Rate	775	436	508	508	814	814	814
Actual	...	436	508	508	318	318	318
Total rolling hp	40,400	22,650	26,400	26,400	42,250	42,250	42,250
Rolling hp, F-1 to F-4	7,650	4,300	5,000	5,000	8,000	8,000	8,000
Rms hp, F-1 to F-4	...	4,300	5,000	5,000	5,000	5,000	5,000
Rolling time, sec	90.0	80.0	80.0	90.0	90.0	107.4	90.0
Gap time, sec	...	0	0	0	140.0	167.0	140.0
Rolling time, per cent	...	100.0	100.0	100.0	39.1	39.1	39.1

* Rolling 1.000-in. thick bar to 0.072-in. thick strip, 5000 hp F-1 to F-4 motors, 100 per cent rms.

TABLE IV
A 66-In. Hot Strip Finishing Mill*

Width, in.	48	24	32.1	36.05	50.25	60	60
Length, in.							
Slab	30	30	30	30	30	30	25.1
Bar	240	240	240	240	240	240	201
Strip	3,333	3,333	3,333	3,333	3,333	3,333	2,790
Delivery speed, fpm	2,222	2,500	2,500	2,222	2,222	1,860	1,860
Tons per hr							
Rate	775	436	584	584	814	814	814
Actual	...	436	584	584	421	421	421
Total rolling hp	40,400	22,650	30,350	30,350	42,250	42,250	42,250
Rolling hp, F-1 to F-4	7,650	4,300	5,750	5,750	8,000	8,000	8,000
Rms hp, F-1 to F-4	...	4,300	5,750	5,750	5,750	5,750	5,750
Rolling time, sec	90	80	80	90	90	107.4	90
Gap time, sec	...	0	0	0	83.8	100.0	83.8
Rolling time, per cent	...	100	100	100	51.8	51.8	51.8

* Rolling 1.000-in. thick bar to 0.072-in. thick strip, 5000 hp F-1 to F-4 motors, 115 per cent rms.

six stands, and the rolling loads are 7650, 7650, 7650, 7650, 6100 and 3700 hp respectively on the six stand drives. The mill rolling rate is 775 net tons per hr.

From this basic power calculation the conditions for other strip widths and rolling speeds can be prorated, and the interval or "gap time" between successive strips and the corresponding hourly mill production to stay within specified maximum rolling loads and rms loads on the stand drives can be determined. The tabulated data in Table III and the solid curves in Figure 3 are on the basis of tentatively selected 5000-hp motors on stands F-1, F-2, F-3 and F-4 (4000 hp on F-5 and 2500 hp on F-6) and with maximum rolling loads limited to 160 per cent of the motor rating (8000 hp on F-1 to F-4) and rms load limited to 100 per cent of the motor rating (5000 hp on F-1 to F-4). With class B insulation, 40-C rise rated motors and the further assumption that maximum production will not persist for more than a few hr at a time, most operators consider that some limited time overload may be permissible and the tabulated data in Table IV and dashed curves in Figure 3 are on the basis of the same 160-per cent maximum rolling load but 115-per cent rms load (5750 hp on F-1 to F-4).

In Table III the first column copies the pertinent

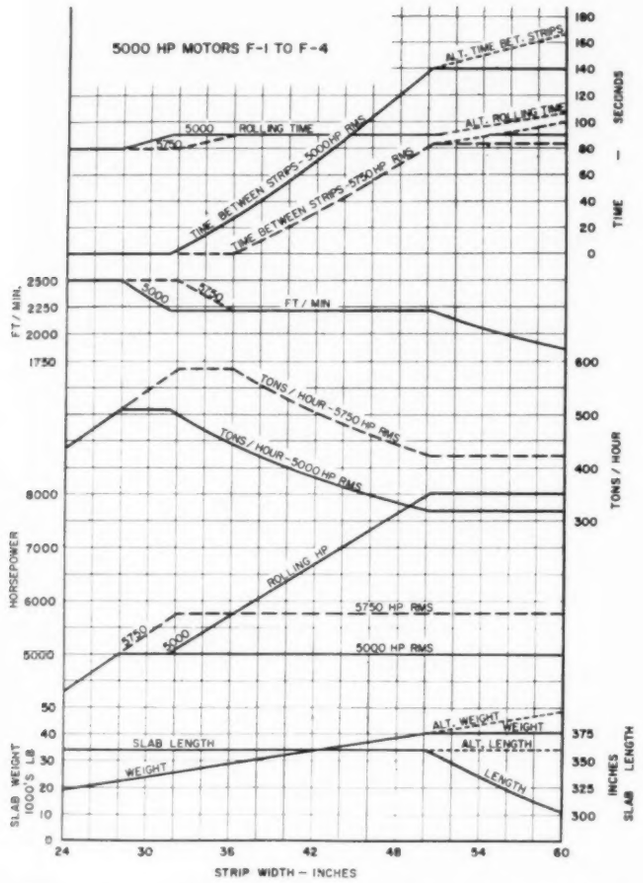

Figure 3 — Curves illustrate production capability when rolling 1-in. bar to 0.072-in. strip, using 100 and 115-per cent rms loads.

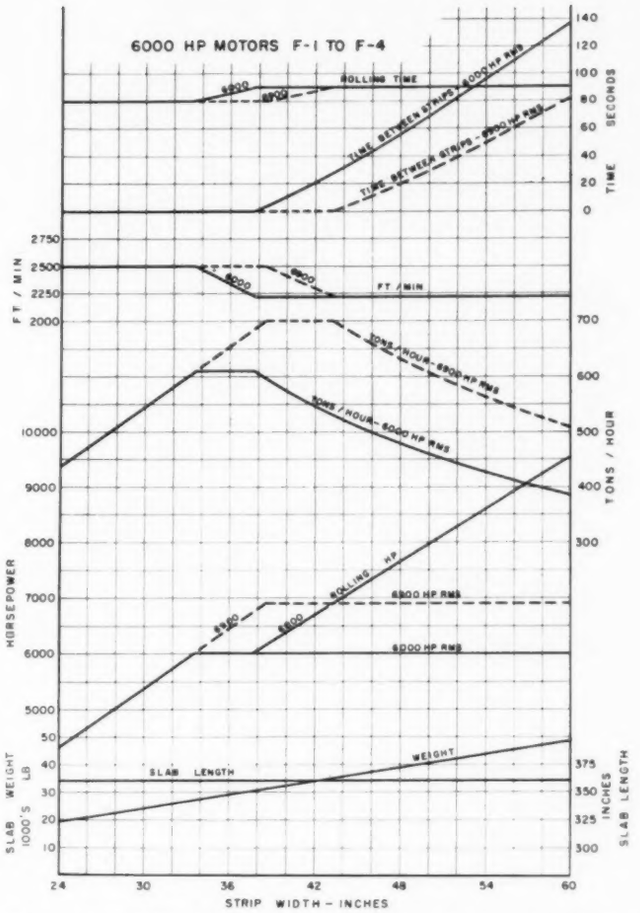

Figure 4 — Mill production capability is tabulated for rolling 1-in. bar to 0.072-in. strip, using 100 and 115-per cent rms loads.

data from the basic calculation on Table II for rolling 48-in. wide strip at 2222 fpm requiring 90-sec rolling time and imposing 7650-hp (F-1 to F-4) rolling loads. The second column is for rolling 24-in. wide strip at 2500-fpm desired maximum speed, with 80-sec rolling time. The 4300-hp rolling load is less than the 5000-hp permitted rms load so the mill can be kept 100 per cent full with zero gap time, and the actual hourly production is the same as the instantaneous rolling rate, 436 tons per hr.

A delivery speed of 2500 fpm can be maintained with increasing strip width up to 27.9 in., as shown in the next column, at which point the rolling load becomes 5000 hp, still permitting operation with zero gap time, keeping the mill 100 per cent full and increasing production with the width to 508 tons per hr.

A 2500-fpm delivery speed corresponds to 80-sec rolling time which is less than the 90 sec permitted time, so the speed is reduced in inverse proportion to the width, and at a width of 31.4 in. the speed becomes 2222 fpm, rolling time increases to 90 sec, rolling load remains 5000 hp, the mill can still be kept 100 per cent full with zero gap time and production capacity remains 508 tons per hr.

To stay within the 90-sec rolling time limit, the speed must be maintained at 2222 fpm, and the rolling load increases in proportion to the width, reaching to 160 per cent, 8000-hp limit at a width of 50.25 in. With the rolling load greater than the permitted rms load, the per cent rolling time that the mill can be kept full decreases in proportion to (rms load/rolling load)^2 and at a width of 50.25 in., the rolling time is reduced to 39.1 per cent and the gap time between strips has to be 140 sec. Thus although the instantaneous rolling rate increases in proportion to the strip width, this is more than offset by the decreased rolling time so that the actual production capability decreases inversely with the width to 318 tons per hr at a width of 50.25 in.

For strip wider than 50.25 in., the speed must be reduced in inverse proportion to the width, in order to keep the rolling load at the 8000-hp limit. Then if the slab length, strip length and 806 lb per in. coil size are kept the same as with narrower strip, the rolling time will increase beyond the 90-sec limit to 107.4 sec at a width of 60 in.; or alternatively if the rolling time is to be kept at the 90-sec limit, the slab size must be reduced to 675 lb per in. at a width of 60 in. In either case the gap time between strips must be varied to keep the mill 39.1 per cent full, and the production capability remains constant at 318 tons per hr.

Operation at 115-per cent rms load—The tabulation in Table IV and the dashed curves in Figure 3 are for the same 0.072-in. strip schedule as Table III and the solid curves in Figure 3, but with the stand drive rms load set at 115 per cent of the motor rating (5750 hp on F-1 to F-4). Since the drives still have the same

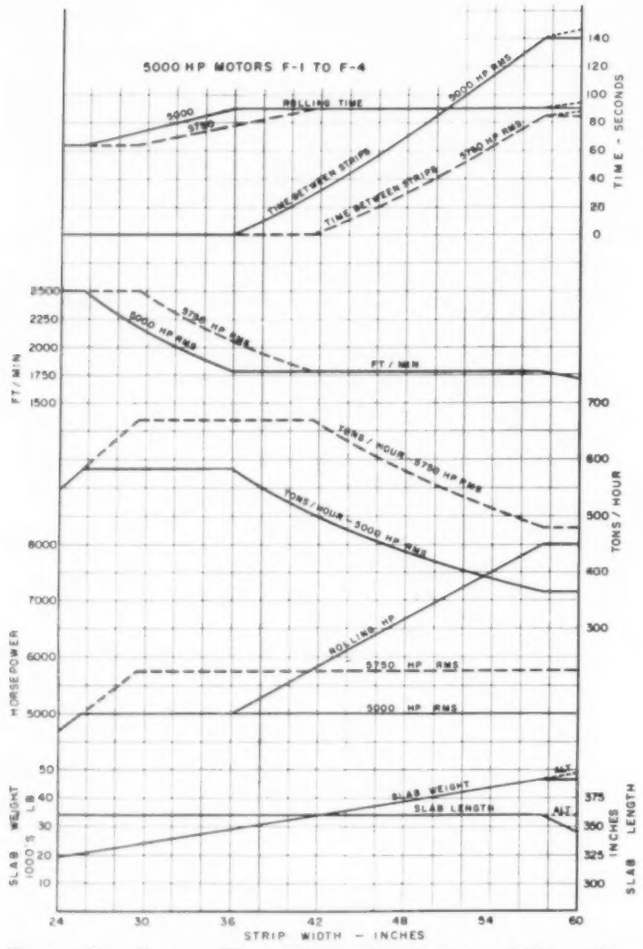

Figure 5 — Curves illustrate production capability when rolling 1-in. bar to 0.090-in. strip, using 100 and 115-per cent rms loads.

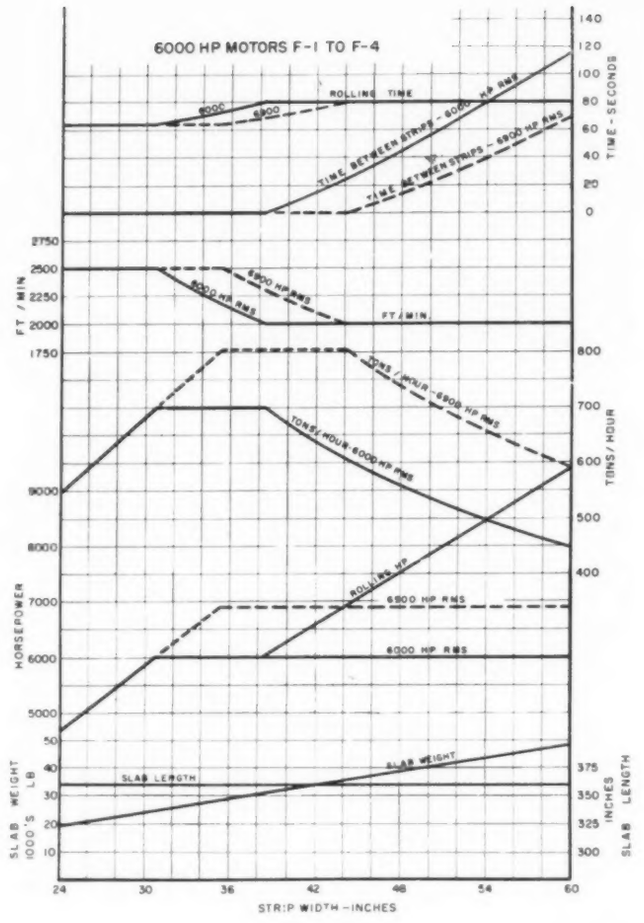

Figure 6 — Mill production capability is tabulated for rolling 1-in. bar to 0.090-in. strip, using 100 and 115-per cent rms loads.

8000-hp maximum rolling load capacity, the per cent rolling time (rms load/rolling load)^2 becomes 51.8 per cent instead of 39.1 per cent for widths greater than 50.25 in., with correspondingly shorter gap time between strips. Thus the production capacity for widths greater than 36.05 in., by increasing the permitted rms load but keeping the rolling load the same, increases as the square of the permitted rms load.

Operation with 6000-hp stand motors—As noted by the tabulated data and the curves in Figure 3, the speed had to be reduced for strip wider than 50.25 in. in order to stay within the 8000-hp maximum rolling load limit, and long gap times had to be allowed beyond 31.4 to 36.05 in. wide in order to stay within the 5000 to 5750-hp rms load limit. Therefore, consideration is given to the use of 6000-hp motors on stands F-1 to F-4 (with 4800 hp on F-5 and 3000 hp on F-6). Figure 4 shows the operation with these larger motors, permitting F-1 to F-4 rolling loads up to 9600 hp, with the solid line curves for 100 per cent, 6000-hp permitted rms load and the dashed line curves for 115 per cent, 6900-hp permitted rms load. The increased rolling load capacity enables the 2222-fpm delivery speed and 90-sec rolling time to be maintained up to maximum 60-in. wide strip, and the increased rms load capacity permits a much higher percentage rolling time, reduces the gap time and thus increases mill output.

Rolling 0.090-in. thick strip—Similar detail power calculations were made for rolling 1.000 in. thick by 240-ft long bar (rolled from an 8 in. thick by 30-ft long slab at the roughing mill) to 0.090 in. thick by 2667-ft long finished strip, with drafting selected so as to impose equal 1.0 pu loads on each of stands F-1 to F-4, 0.8 pu load on F-5 and 0.5 pu load on F-6. For this load pattern, the reductions are about 49, 42, 36, 30, 22.5 and 15 per cent respectively in the six finishing stands.

Figure 5 shows the operation for the 1.000-in. bar to 0.090-in. strip schedule, with 5000-hp F-1 to F-4 motors (4000-hp F-5 and 2500-hp F-6) enabling rolling loads up to an 8000-hp maximum. Again the solid line curves are for 100 per cent, 5000-hp F-1 to F-4 permitted rms load, and the dashed line curves are for 115 per cent, 5750-hp F-1 to F-4 permitted rms load. With the higher permitted rms loading, the percentage rolling time is increased, the gap time is reduced, and for widths where the rolling load exceeds the permitted rms load, the tons per hr production capacity increases as the square of the permitted rms load.

Figure 6 shows the operation for rolling the 1.000-in. bar to 0.090-in. strip schedule, with 6000-hp F-1 to F-4 motors, enabling the F-1 to F-4 rolling loads to go up to 9600 hp. Also the solid line curves are for 100 per cent, 6000-hp F-1 to F-4 rms load, and the dashed line curves are for 115 per cent, 6900-hp F-1 to F-4

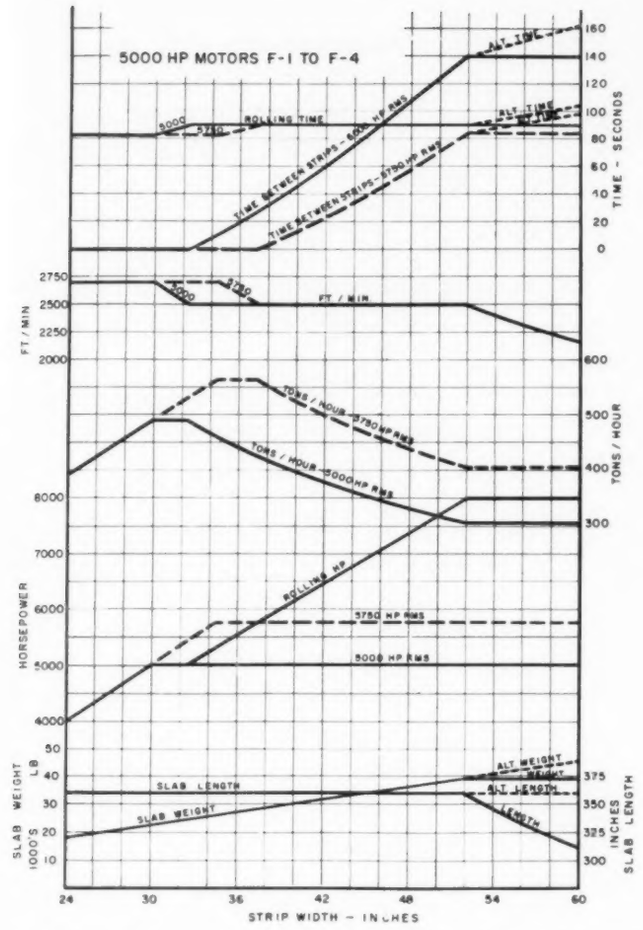

Figure 7 — Curves illustrate production capability when rolling 0.90-in. bar to 0.060-in. strip, using 100 and 115-per cent rms loads.

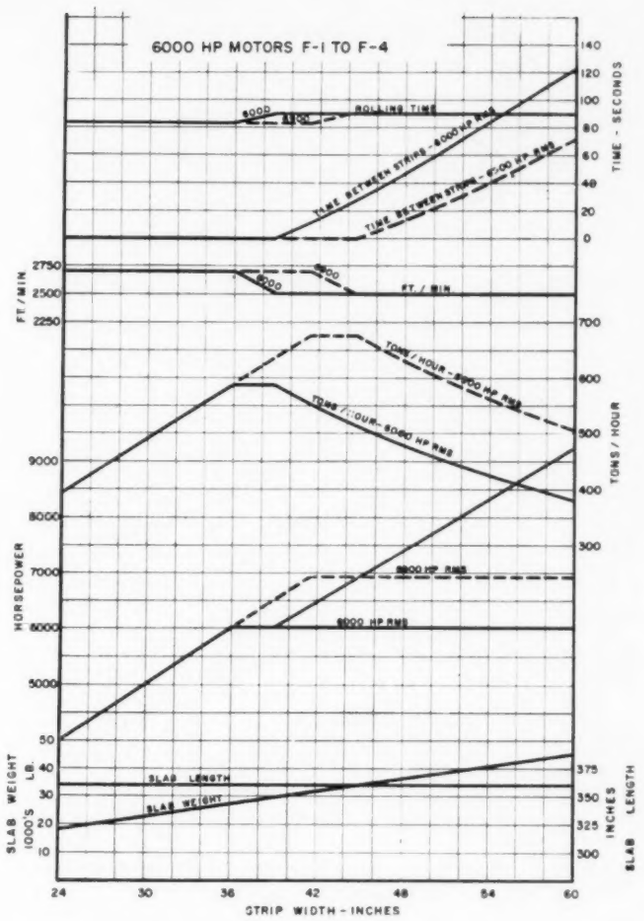

Figure 8 — Mill production capability is tabulated for rolling 0.90-in. bar to 0.060-in. strip, using 100 and 115-per cent rms loads.

permitted rms load. Figure 6 is not directly comparable with Figure 5, as the increased power enables operation at higher minimum speed (2000 vs 1780 fpm) with maximum rolling time thus limited to 80 sec as compared to 90 sec in Figure 9.

Rolling 0.060-in. thick strip—Power calculations were also made for rolling 0.900 in. thick by 250-ft long bar to 0.060 in. thick by 3750-ft long finished strip.

Because of the long length of the thin finished strip, it did not appear practicable to maintain the slab size, and the schedule is on the basis of a 7.50 in. thick by 30-ft long starting slab, corresponding to 756 lb per in. of width. Drafting was selected at 54.5, 45, 37, 32.5, 25 and 16.7 per cent respectively in the six finishing stands, to place 1.0 pu load on each of stands F-1 to F-4, 0.8 pu load on F-5 and 0.51 pu load on F-6.

Figure 7 shows the operation with 5000-hp motors on stands F-1 to F-4 enabling rolling loads up to 8000 hp on these stands. The solid line curves are for 100 per cent, 5000-hp F-1 to F-4 permitted rms load, and the dashed line curves are for 115 per cent, 5750-hp rms. A 2700-fpm delivery speed was selected for the narrower strip, and it should be noted that 2500-fpm delivery speed must be maintained in order to deliver the 3750-ft long strip within the 90-sec time limit. Also, similar to the condition in Figure 3, the rolling load reaches its 8000-hp limit at 51.9 in. wide, and for greater widths the speed must be reduced in order to stay within the rolling load limit. This is accomplished either by increasing the rolling time beyond 90 sec if the slab size is maintained, or alternatively by reducing the slab size if the rolling time is to be kept at the 90-sec limit.

Figure 8 shows the operation for rolling the 0.900-in. bar to 0.060-in. strip schedule, with 6000-hp F-1 to F-4 motors, enabling up to 9600-hp rolling load on these stands. The solid line curves are for 100 per cent, 6000-hp F-1 to F-4 rms load, and the dashed line curves are for 115 per cent, 6900-hp F-1 to F-4 permitted rms load. With this drive capacity a 2500-fpm delivery speed, corresponding to 90-sec rolling time for the 3750-ft long finished strip, can be maintained up to 60-in. maximum strip width, so that 756 lb per in. width coils can be produced over the entire width range.

PRODUCTION CAPABILITY FOR DIFFERENT SCHEDULES

The curves in Figures 3 to 8 have shown the relations of slab size, rolling speed, rolling and rms loads, rolling time, gap time and tons per hr production capability, for the assumed hot strip finishing mill, with two different sets of ratings of drive motors, and for three different schedules producing 0.072, 0.090 and 0.060-in. thick finished strip. However, the end goal has been to determine the tons per hr production capability

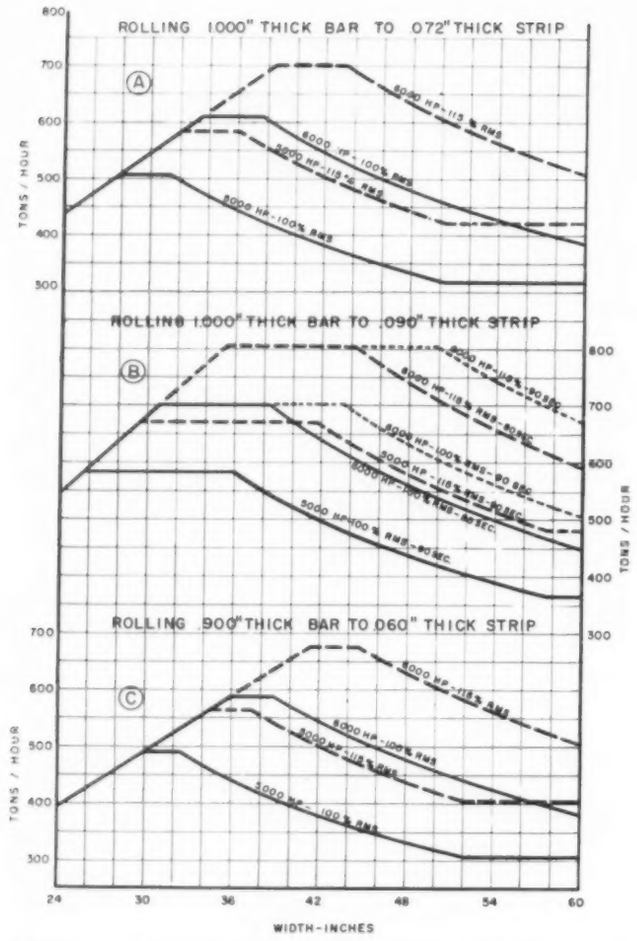

Figure 9 — Comparison of curves indicates that maximum tons per hr for one mill are generally obtained over a narrow width range.

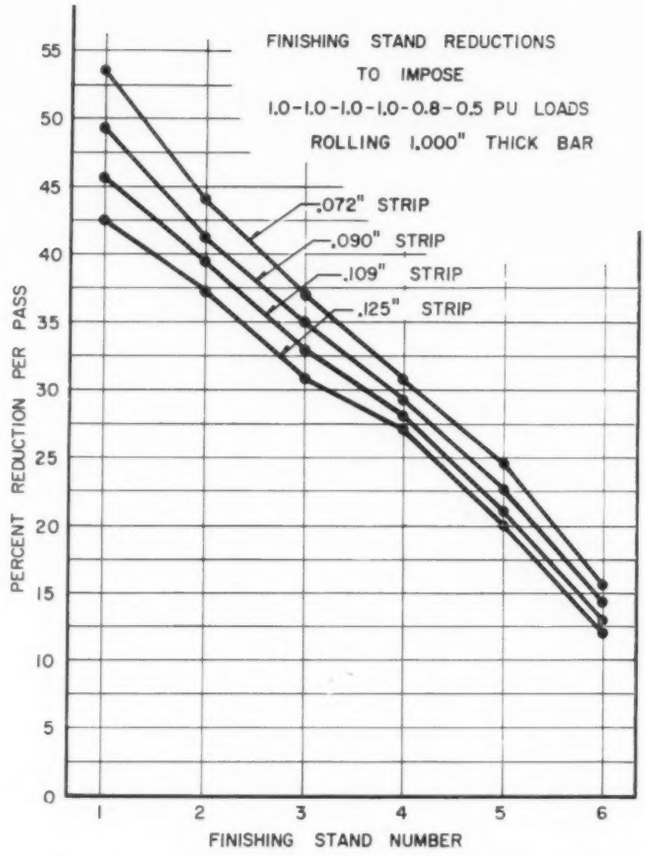

Figure 10 — The hot mill study has assumed specific per unit loadings on the mill stands.

of the mill under various other conditions; therefore, in Figure 9 only the tons per hr curves from the preceding six charts have been brought together for comparison. The top group of curves (A) is for the 1.00-in. bar to 0.072-in. strip schedule, the lower solid curve being for 5000-hp motors, 100-per cent rms load, the lower dashed curve for 5000-hp motors, 115-per cent rms load, middle solid curve for 6000-hp motors, 100-per cent rms load, and top dashed curve for 6000-hp motors, 115-per cent rms load.

The middle group of curves (B) is for the 1.000-in. bar to 0.090-in. strip schedule. In connection with this group of curves, note that in Figure 5 showing operation with 5000-hp motors, a 90-sec rolling time limit was assumed, while in Figure 6 the 6000-hp motor rating enabled operation within an 80-sec rolling time limit. These conditions from Figures 5 and 6 are shown by the solid and dashed curves on Figure 9; in addition, the dotted curves were drawn to show the tons per hr capability with 6000-hp motors and with a 90-sec rolling time limit. These additional curves show very strikingly the gain in output capability by operating at the lowest practicable speed for the highest practicable percentage of the total time.

The bottom group of curves (C) on Figure 9 is for the 0.900-in. bar to 0.060-in. strip schedule, and shows essentially the same relations as for the 1.00-in. bar to 0.072-in. strip schedule.

FINISHING MILL LOAD DIVISION AND DRAFTING PATTERN

The hot strip mill study assumed equal 1.0 pu loads on stands F-1 to F-4, 0.8 pu load on F-5 and 0.5 pu load on F-6, as this has been observed as a usual approximate load division on different operating mills. Also it has been noted, in connection with the different detail calculations, that to obtain this load division requires making the largest percentage reduction in stand F-1, and gradually decreasing percentage reductions in each succeeding stand. Data have been taken from a typical HHT-elongation curve, from which have been calculated the reductions per pass to reduce 1.000-in. thick bar from the roughing mill to various finished hot strip thickness, which are required in order to divide the total finishing mill load in 1.0, 1.0, 1.0, 1.0, 0.8 and 0.5 pu ratio on the six stands. The results shown by Figure 10 clearly indicate that this load division pattern requires the heaviest reduction in F-1 and gradually decreasing reductions in succeeding stands. Figure 11 shows similar required drafting patterns for rolling 0.900-in. thick bar to various lighter finished hot strip, with the same assumed 1.0, 1.0, 1.0, 1.0, 0.8 and 0.5 pu loads on the six stands.

Some mill operators may prefer to take somewhat lighter reduction in stand F-1, and thus impose lighter load on the F-1 drive, with heavier reductions and loads on later stands. The solid curve in Figure 12 shows the drafting pattern required to reduce 1.000-in. starting bar to 0.072-in. finished strip with 1.0, 1.0,

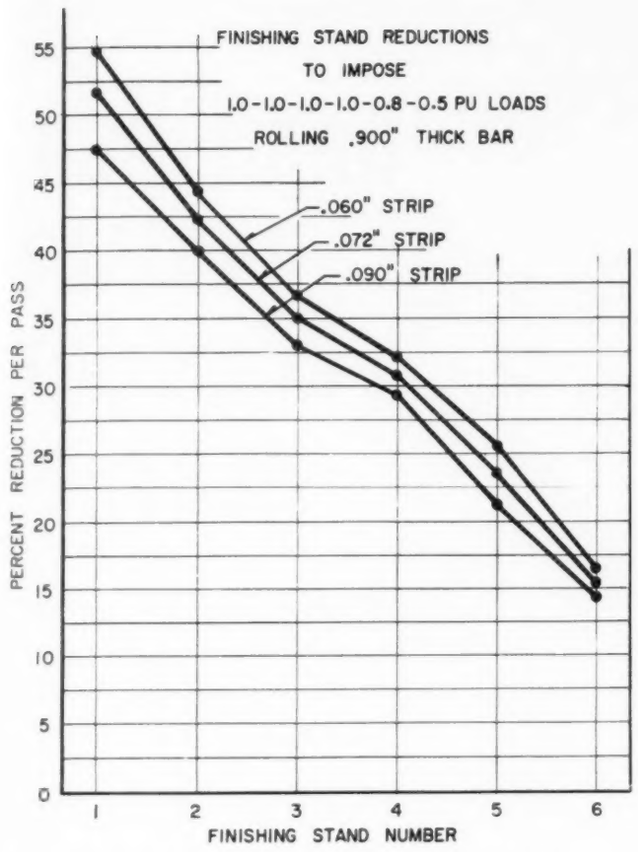

Figure 11 — Calculations involving the 0.90-in. bar assuming specific per unit loadings.

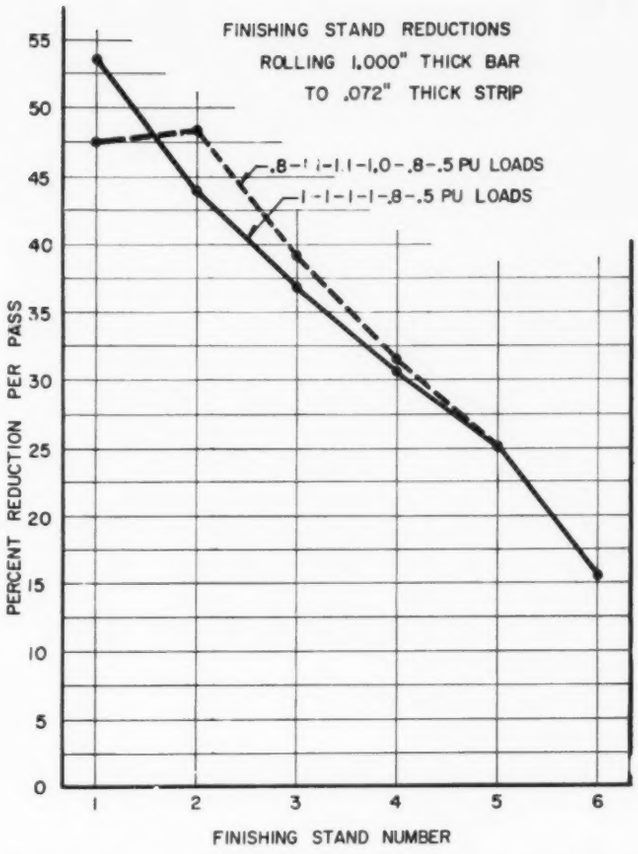

Figure 12 — The per unit loadings can be varied to change stand loading.

1.0, 1.0, 0.8 and 0.5 pu loads, and the dashed curve shows the comparative drafting pattern for the same total reduction but with 0.8, 1.1, 1.1, 1.0, 0.8 and 0.5 pu loads, the lighter work in F-1 being made up in stands F-2 and F-3.

SUMMARY

Only a few of the factors involved in the selection of rolling mill drive ratings, and variation in mill production capability with different drive capacities have been discussed. However, it is felt that a new approach has been shown for graphically showing the mill capability for a range of product sizes, within the limiting parameters of motor maximum peak and rms loads, delivery speed, finishing mill time, slab size, division of load among stands, etc. The study of the typical assumed mill emphasizes that for high production rates, major consideration must be given to the drive motor rms capacity as well as to the maximum rolling load capacity.

General availability of computer facilities enables more extensive study over wider ranges of limiting parameters to assure that selected drive ratings will best meet the specified operating conditions.

It is hoped that this article may stimulate further development of ways by which a greater volume of computed data may be graphically represented to show the operational capability of a proposed mill over the range of product sizes, with different combinations of drive capacity.

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GAS-FIRED, RADIANT COMFORT HEATING

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FROM the dawn of creation, man has been dependent upon radiant heating in his struggle for survival in competition with other presumably less intelligent forms of life.

First, the radiant heat from the warm tropical sun, and then radiant heat from prehistoric camp fires allowed man to migrate into colder hunting grounds. Similar crude sources of radiant heat down through the ages have instilled a fascination for the naked flame which is perpetuated today with open fireplaces and outdoor grilles.

However, this affectionate regard for the sight of smoke and flame has not obscured the fact that the conventional open fireplace alone, with all of its radiant heat, provides neither comfort nor space heating. While residential heating has been improved tremendously in the past decade, high ceilinged industrial buildings have defied a satisfactory heating solution until the very recent introduction of gas-fired infrared radiant heating equipment.

PRINCIPLES OF RADIANT HEATING

For a review of terms, a hand placed in contact with a steam radiator is heated by conduction. If the hand is held above the radiator, heat is transferred to the hand principally by convection by the upward moving currents of warm air. If the hand is held to one side, heat continues to reach it but this time by radiation.

The physical principle of the transfer of heat by radiation was expressed by Josef Stefan in 1879 when he concluded that the rate of radiation is proportional to the fourth power of the absolute temperature (degrees K) of the source.

A conventional steam radiator has a surface temperature of approximately 200 F or 660 K. If the temperature is tripled to 1980 K or 1520 F, as with a low-grade gas-fired radiant heater, the radiant energy emitted is therefore increased to 3^4 or 81 times that of the steam radiator! Actually even higher temperatures are normal.

Obviously, for equal heat inputs, it must then follow that the conduction and convection heat emission must be much less from the gas-fired unit than from the steam radiator. Therein lies much of the economy of operation of the gas-fired unit. Practically no heat is lost upward by convection.

The remainder of the economy is due to the fact that the infrared radiant heat can be and is directed away from the walls where it would be lost by conduction. Thus a heated interior is achieved with minimum heat losses to the walls and roof.

The needs for this new efficient form of industrial heat are being met by a rapidly increasing number of suppliers. Their ultimate success will be determined by how effectively they can combine these several requirements and competitively meet industrial needs.

HEATER CONSTRUCTION

A description of the natural gas-fired infrared radiant heater itself should be first. The essential element was originally a ceramic refractory tile, about five in. wide and eight in. long, $\frac{3}{8}$ in. thick and perforated with some 200 holes per sq in. Competitive units are using metallic burning grids or vitreous-coated metal heat exchangers with and without a reverberatory screen. The tile, or burner grid, is supported in a cast or fabricated metal housing. A jet of natural gas is introduced through an orifice and a venturi where it aspirates primary combustion air, the mixture passing into a miniature plenum chamber behind the tile. The air-gas mix is directed against a baffle, creating turbulence which converts the velocity energy into static pressure, driving the combustible mixture through the tiny holes of the burner face.

The surface of the burner is heated to between 1800 and 2000 F. A heat resisting reverberatory wire mesh screen or "combustion intensifier" may be used to improve the combustion efficiency. Any number of individual tile burners are included within a polished aluminum reflecting frame. This reflector is essential to confine the infrared rays to the object to be heated and away from the walls.

AN INITIAL INSTALLATION

The relatively modern concept of infrared radiant heating met with little initial enthusiasm locally. The open flame could not be ignored from the safety standpoint, and there was much skepticism that comfort heat could be achieved with less capacity than conventional heat loss calculations would dictate.

Yet very satisfactory comfort, gratifying first-cost savings and operating cost economies were all achieved in the 1959–1960 winter from one initial natural gas-fueled radiant space heating system installed in the roll shop at the Lorain works as shown in Figure 1. These results were obtained, however, only after a year of trial and error experimentation with this controversial

. . . . radiant heating can be used for various zones within a large building, to permit the people working in any one area to work in comfort, while another section of the building might be unheated . . . .

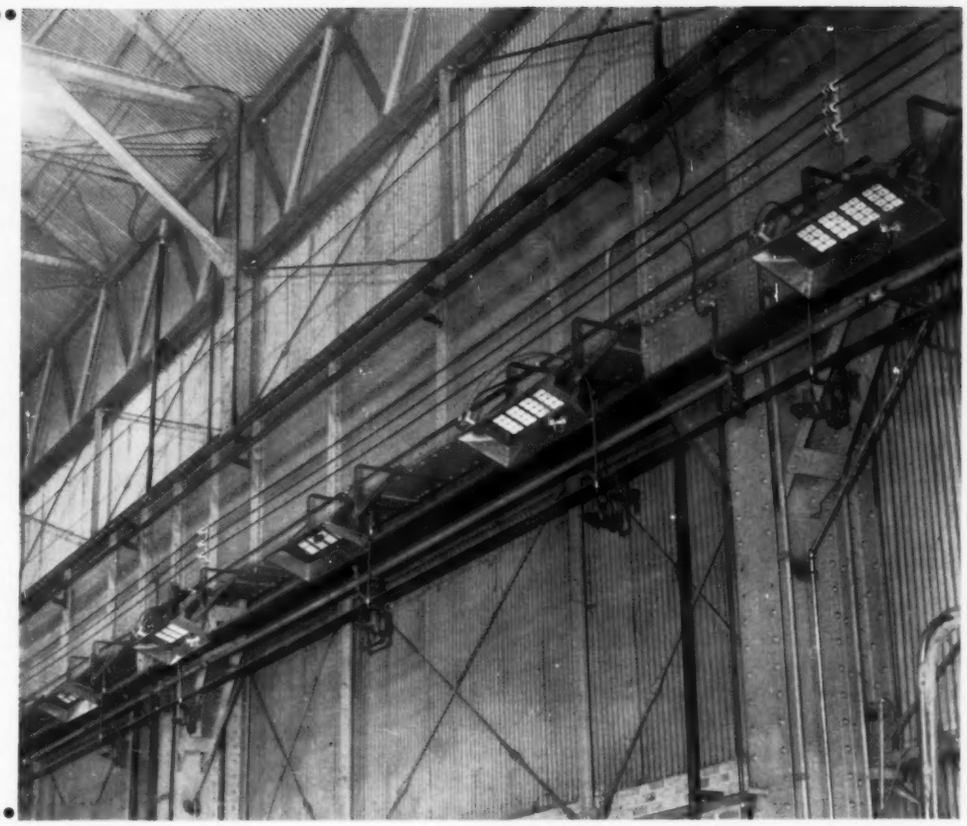


Figure 1 — Heaters were mounted underneath the crane runway to provide low angle incidence radiation.

heating equipment, which apparently violated so many preconceived and well-established building heat loss theories.

The building which has been heated so satisfactorily despite the unusual cold days of the 1959–1960 winter is 250 ft long, 50 ft wide and 60 ft from the floor to the peak of the roof. The walls and roof are of uninsulated corrugated steel sheathing. Formerly used for roll storage only, there had been no central heating system required nor provided.

The shop which is now used for roll turning by personnel who had been accustomed to warmly heated quarters, is provided with two large railroad doors, one on each side of the shop, which permit standard gage cars to enter or leave whenever rolls are to be transferred from one building to another.

All units consist of four burner heads in a row within a reflector frame. A total of 27 of these units are mounted 36 ft above the floor (five ft above the crane for easy maintenance) and 41 are mounted around the perimeter of the building, under the crane runway, at a height of 17 ft. Each unit delivers 48,000 Btu per hr or 340 Btu per hr per sq in. of burner tile. This energy is delivered without intentional air movement or stratifying air currents. Personnel and equipment are in effect sandwiched between the rays directed toward the floor and the secondary radiation rising from the floor.

FACTORS INFLUENCING INSTALLATION

The decision to install direct gas-fired radiant heating units in this building was influenced by the following factors:

1. Natural gas, in sufficient quantity and at adequate pressure, was conveniently available.
2. There was no surplus of modern steam generating capacity available for this additional winter heating load.
3. Gas-fired infrared heaters offered the best possibility for achieving comfortable shop temperatures for the men, and uniform temperatures for accurate roll bearing assembly work. Conventional systems, to achieve equal comfort, would have required insulation to reduce the chilling effect of large uninsulated wall and roof areas. The estimated cost of insulation alone was greater than the total cost of the radiant heating installation.
4. The adoption of infrared radiant heating offered an opportunity for a full scale trial installation to serve as a guide for future applications.
5. Most attractive potential fuel economies seemed possible. Fuel requirements appeared to be only about 40 per cent of the calculated conventional building heat losses.
6. Additional fuel economies were almost assured, with natural gas instead of coal. On a straight Btu basis, coal is unquestionably the lower cost fuel. However, when winter heating coal must first be thawed with gas and then hand unloaded in small quantities, the energy cost is increased appreciably. If this coal is then burned in marginal 43-year old steam boilers with their original settings, on chain grate stokers designed for coke breeze, the resultant steam, when delivered for heating, has an actual incremental unit cost considerably higher than that of natural gas.
7. The simplicity of design of such a heating system

offered intriguing possibilities for lower maintenance than competitive forms of heating. It now appears that maintenance will consist of an annual polishing of the aluminum reflectors and compressed air cleaning of the face and back of the refractory tile.

8. An appreciable savings of space was achieved. One small uninsulated gas line serves each heating unit, there are neither condensate returns, nor drain lines to take up wall space. Furthermore 27 of the units are mounted in the unused space above the crane.

All of these objectives have finally been achieved. It is now a most satisfactory installation thanks to the cooperation of the equipment suppliers and various local groups involved in the installation. The management of the building and the occupants deserve special mention for their patience, in view of the lack of comfort during the first winter of trial and error.

INITIAL TROUBLES

The following unexpected troubles were experienced with the initial installation and have since been overcome.

1. The total capacity of the heating units originally installed was inadequate. With no previous experience with this type of heating it was decided that 25 per cent of the conventional total would be tried initially. However, when the installation was unable to provide comform except on relatively mild days, the capacity was substantially increased, although it still totals only 40 per cent of the requirement indicated by standard heat loss calculations.

2. All of the units were initially mounted five ft above the cranes. Now 60 per cent of the total capacity has been relocated and mounted on the outside walls some 17 ft above the floor, and directed to the floor. The remaining 40 per cent is still overhead.

3. The original overhead units were equally spaced but are now more concentrated in the center of the building, close to the large railroad doors, one or both of which are frequently open. Admittedly, shirt-sleeve comfort cannot be maintained during the time a door is open to the chilling blast of the cold winter wind. But the ceiling heaters, with the help of the secondary radiation from the floor, do restore normal comfort far more quickly than had been anticipated.

4. The 60-ft building height, coupled with the warm building air and the products of combustion from the burner, do create a perceptible stack effect. Infiltration of outside air around doors, windows, cracks, etc., not objectionable when the building was unheated, cannot be tolerated in sub-freezing weather. While the heaters are not individually vented, the building as a whole is provided with free ventilation equivalent to 50 sq in. for each 100,000 Btu of the 4,000,000 Btu of installed capacity. Obviously, the direct-fired heating requires make-up air in sufficient quantities both for combustion and for dilution of the products of combustion sufficient to prevent moisture from condensing on the walls or dripping from the roof. As the more obvious ground level air leaks were corrected, the chilling effects of those that remained increased until it became apparent that satisfactory comfort could not be effected short of the complete elimination of all air leaks at ground level. Sufficient fresh air is permitted to enter at the higher levels, and four 3-ft diameter roof vents provide very satisfactory moisture, fume and odor removal.

5. The original heating element design was faulty in some units, restricting the inspiration of adequate primary combustion air. This resulted in a sooty deposit on the wire screens over the radiant tiles, which substantially reduced their effectiveness. An improved burner design has been substituted which has eliminated this deficiency.

6. The original heating units were rigidly piped, so that expansion of the piping, or crane movements distorted the units.

The units are divided into seven perimeter and four overhead zones, each zone thermostatically controlled by a conventional thermostat which is mounted on the web of an adjacent building column, where each thermostat is shielded from direct radiation. A small pilot light stays lit at each unit and the thermostat actuates a shutoff valve in the branch gas line. Uniformly satisfactory regulation has been achieved.

Natural gas is furnished by the local gas company at pressures ranging from 80 to 110 psig. This gas is metered and distributed through an overhead piping system throughout the rolling mill area, under full line pressure to those consumers who require the higher pressures: burning, scarfing, hot deseaming, etc. The gas pressure is then reduced as required at each point of ultimate consumption. Gas pressure for the roll shop heating system is reduced to 20 psig for distribution within the building, and further lowered to six oz at each individual unit.

ALTERNATE FACILITIES REQUIRED

On July 7, 1959, after this installation was completed, the Public Utilities Commission of Ohio ruled that stand-by fuel facilities with capacities satisfactory to The Ohio Fuel Gas Co. shall be provided by the consumer and used when requested by the utility, for each space heating installation exceeding 1,000,000 Btu per hr in capacity. This will present some real problems to many. At Lorain works, salamanders fired by coke or coke-oven gas will be used in case of any gas service interruptions. Fortunately, Ohio Fuel Gas Co. has an almost perfect record for continuity of service for the past few years, thanks to their progressive development of massive underground storage facilities within 20 miles of Lorain.

OTHER RADIANT HEATING APPLICATIONS

On the open hearth floor across from the furnaces, temperatures are often uncomfortably cool in winter weather and on occasion drop below freezing. A single coke-fired salamander of conventional design had previously been used at each "pull-up" shanty both for the protection of the instrumentation and the comfort of personnel. This salamander occupied valuable floor space, and created a housekeeping, safety and odor problem. The salamander was invariably too hot or too cold, required excessive labor to service and was tolerated only because there was no satisfactory substitute. Unit heaters created cold drafts, and the area was too small and exposed for an adequate installation of steam radiation.

Although the limited head room available created some apprehension, the soft, warm glow of a single unit has eliminated the objectionable features of the salamander and provided automatic, uniform comfort.

A more ruggedly constructed infrared heat generating unit is being installed in the pulpit for the shear operator in the scrap yard. The building is only a crude, 3-sided shelter, six ft wide, ten ft high and 40 ft long, and is constructed of corrugated sheet iron.

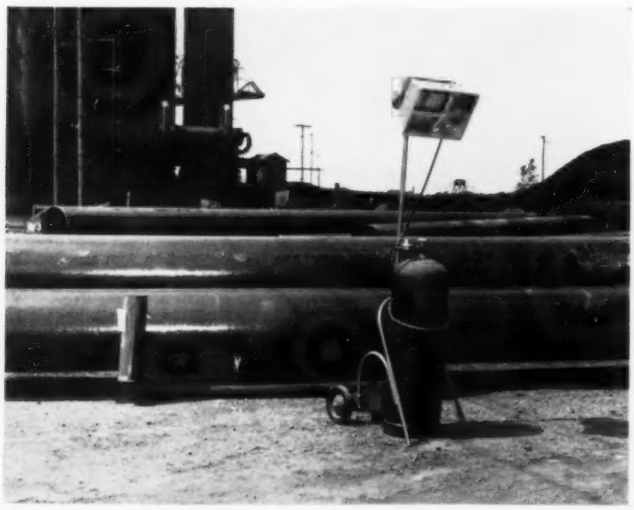
The north side is open to the weather and the only heating has been a single coke-fired salamander. Three overhead radiant heat units have now been installed. These units are fitted with "honeycomb" windshields of ¼-in. metallic strips which protect the burner face. The units also are equipped with self-contained thermocouple-generated power controls which eliminate wiring. It is believed that this installation will solve this heating problem.

Another infrared heating installation planned for this coming winter has interesting implications. The area to be heated is approximately 100 by 90 ft and is inside a pipe mill building covering 25 acres. The building as a whole is kept above freezing by spot salamanders but a relatively constant temperature is desired in this smaller area where new threading machines are to be put in operation.

Natural gas-fired infrared heating units, delivering 350 Btu per hr per sq ft of floor area, will be installed both above the traveling crane and just under each crane runway. To minimize building drafts a windbreak partition has been built under each crane runway. No partitions are planned from runway to runway but may be required later.

Formerly, the occasional emergency repair job in an isolated, cold and exposed location such as a river intake blocked with ice, meant working under the most adverse conditions. This condition has been alleviated by the use of portable, propane-fueled infrared heating units shown in Figure 2. These can be easily transported in the trunk of a personal car in an emergency. On the site, they can be wheeled into position in multiples of one, two or three as required. Rated at 24,000 Btu per hr each, they can operate for more than three days of continuous operation on a single tank of propane. With a windbreak, relative comfort can be achieved, but even without a windbreak these heaters are far superior to the obsolete salamander which was difficult to move and even more difficult to operate effectively.

Figure 2 — Portable, infrared heaters can be used for spot heating during emergency repair work.



Extensive usage of propane in the portable units can be justified only if the cost of piping natural gas to the location of the unit exceeds the high cost of burning propane.

While used primarily for space or process heating, these devices have been adapted satisfactorily to metallurgical heating for such a simple application as preheating roll neck bearings or shaft sleeves to expand them for a shrink fit. Two burners are mounted over a wheeled box in which the bearings or sleeves are heated. However, an attempt to preheat 12-in. diameter steel rounds was unsatisfactory because of the difficulty of moving the rounds under the burners or moving the burner rig.

CONVERSION OF COKE-FIRED SALAMANDERS

One final application of infrared heating, this time with coke-oven gas, has been the conversion of the general mill heating salamanders in Lorain works. Generations of workmen, in and out of steel mills, have warmed themselves, or protected equipment from freezing with coal, coke or oil-fired salamanders. Lorain works' salamanders were crude devices, made from sections of 20 to 24-in. pipe, both vented and unvented and formerly fired with domestic coke. Each mill has some similar device where spot heating is required, but very seldom are conditions such that one mill can or will adopt the device in use at another.

With improved blast furnace technology, however, the domestic coke is now used in the blast furnaces with the furnace coke. Domestic coke has suddenly become an expensive metallurgical fuel.

Housekeeping has always been a major salamander problem, as well as safety. The trucking, wheeling and shoveling of both coke and ashes constituted a continuing and increasing problem. Coal could not be substituted because of the smoke and the necessity for more frequent refueling, with the perpetuation of all of the inefficiencies and other problems associated with coke.

Substitute heating devices were given a trial and discarded, oil-fueled construction-type salamanders, for example, proved to be hazardous to light and hazardous to refuel. They were always subject to being knocked over with possibly serious consequences from the resulting ignition of the spilled oil.

Demands to be met—Since coke-oven gas was available, often in surplus quantity, the salamanders were converted to gas (Figure 3) in accordance with requirements and restrictions peculiar to Lorain works:

1. Raw coke-oven gas is distributed through insulated, steam-traced piping. This system very effectively prevents winter freezing, but unfortunately also prevents any contaminants from condensing out along the way. Control valves, pilot lights and safety shutoff equipment when tried often become inoperable within 24 hr. Therefore, the only permissible device on the gas line to the conversion burner must be the lubricated plug cock shutoff valve.

2. It was desirable that the conversion from coke to gas could be made, to those salamanders presently in

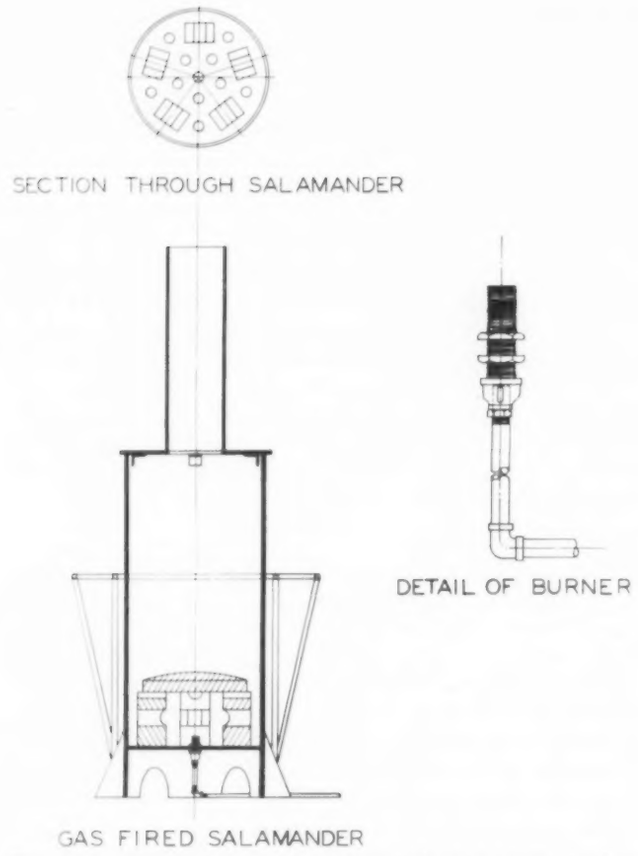


Figure 3 — Conversion of the salamanders to gas operation eliminated coke storage and handling problems.

good condition, a simple economy preferable to wholesale replacement.

3. The burner itself should be simple in construction, with a minimum of restrictions subject to plugging. This was accomplished by assembling an aspirating device wholly from common pipe and standard malleable fittings.

4. Heat must be released in the least possible space because of the limited volume of the salamander. This was accomplished by directing the flame against a ceramic baffle tile made of castable refractory formed in a trash can lid, with a ring set in the top of the baffle to permit lowering it into the salamander.

5. The limited surface area of the salamander further required that the shell be raised to a red heat by the burner, so that heat would be transferred by efficient infrared radiation to offset as much as possible the inherent inefficiencies of a salamander. Simultaneously, it was essential that there be a sufficient mass of glowing ceramic to relight the gas should the flame be momentarily extinguished by a slug of water. These requirements were met by supporting the baffle on several special blast furnace stove tiles whose shape was ideally suited to this purpose.

6. The device should be simple to operate and safe for the least experienced personnel to light. This was accomplished with a small circular hole through the shell near the combustion chamber, through which a rolled up, lighted newspaper could be inserted and observed while opening the gas valve.

7. Written instructions in both English and idiomatic Spanish were distributed to all personnel involved, detailing the correct lighting procedure.

8. As a further precaution against possible failure to follow these simple instructions, a top consisting of a loose fitting "top hat" was installed. This consists of a short stack welded to a cover plate which is slightly larger in diameter than the salamander and which is positioned on top of the salamander with welded lugs. The stack prevents the hot gases from singeing a passerby, and the loose fit permits the top to raise in the event of a "puff." This arrangement also permits the quick and easy replacement of the refractory and baffle when necessary to do so.

By-product coke-oven gas is taken off at the main through a drop leg, to collect any moisture at that point. It is then supplied to the salamanders through small, uninsulated piping to maintain high velocities and prevent freezing, to use the pressure drop as a substitute for pressure regulation and for economy of first cost. Over a hundred salamanders have been converted in this manner, and have operated satisfactorily and without incident to date.

Experience at Lorain works with gas-fired radiant space heating has shown it to be ideally suited to mill-type buildings for comfort at minimum cost.

Figure 4 — Vented radiant heaters can be used in areas where there are no roof vents.

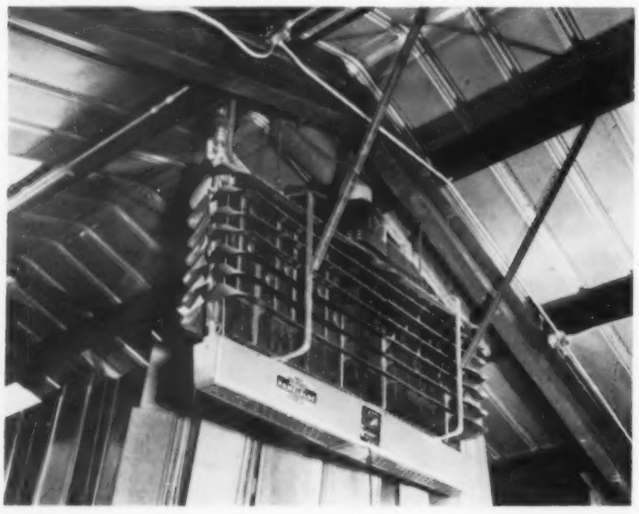


Figure 5 — Low mounting of the heaters permits full body heat exposure.

Discussion

PRESENTED BY

W. E. KOPF, Chief Design Engineer, Cleveland Works Div., Jones & Laughlin Steel Corp., Cleveland, Ohio

PAUL H. GOODELL, Chief Engineer, Panelbloc Div., The Bettcher Corp., Cleveland, Ohio

J. N. EVANS, Superintendent, Fuels and Power, and V. A. URSCHEL, Heating and Ventilating Engineer, Lorain Works, National Tube Div., United States Steel Corp., Lorain, Ohio

Member: The big trouble in the described installation was the lack of knowledge in knowing how to figure the requirements for an infrared system. The knowledge available was very sketchy. Most of it was based on sq ft figures. While that worked out adequately in some buildings, it was very much amiss in others. Today the conventional heat loss method is used. However, a conversion factor is necessary to allow for the infrared radiating surfaces, and there has been general acceptance of this factor throughout the industry.

One of the things that can be accomplished is not only a general pattern of heat in a building but the spot heating of areas. In spot heating there is no longer a rule of thumb. It has to be in the form of a comfort heat. The temperature of the building can be very low, yet every man should be working in a comfort zone in the particular areas one is attempting to heat. The heat does not cause any rise in ambient temperature; however, the man will be comfortable as long as his body temperature is not allowed to decrease below the temperature of about 85 F. That is the outside skin surfaces, so he can be extremely comfortable, yet working in a very large building.

From the economy standpoint this is quite important. Economically, in some of the very large buildings, it is almost impossible to heat them thoroughly, due to the fact that only a few employees are working in that area.

In operating the heating units, it is best to stay within a range of 1550 to 1600 F. With regard to higher temperatures, in the use of infrared equipment for drying, etc., the units are operated at a higher temperature using a premix system. However, this is not utilized in industrial space heating.

There are other fields of the infrared industry: the thawing of all types of bulk materials that come in carloads and are thoroughly frozen when they enter a plant. They must be thawed in order to be utilized properly. Also, there are times that materials must be dried, and with an infrared system that has been done very adequately. The systems are all in small units and can be readily moved from one portion of a building to another if the nature of the business dictates. They are thermostatically controlled so a group of units can be handlocked to one thermostat. One can have very adequate control of various zones in the plant, particularly when one section of the plant may be at work and another section is not. This is where spot heating and partial area heating comes in so adequately.

Infrared heaters can be very adequate for condensation control. This is done, of course, with a control system using a dew-point temperature regulator which will sense the dew point and keep the moisture from condensing on rolled or flat stock.

W. E. Kopf: At J&L's Cleveland works, gas-fired radiant comfort heating for a bearing repair shop was considered. The initial cost, however, was considerably higher than for unit heaters using steam as a source of heat. More recent inquiries for heating a shipping building indicated that gas-fired blower-type heaters are the least expensive to install. Steam heaters cost about 50 per cent more to install than the gas-fired heater. The gas-fired radiant-type heaters were estimated to be the highest initial cost of the three types of heaters. This comparison was based on heater cost installed and did not consider any outside piping of gas or steam. Local conditions as to proximity and availability of gas or steam would no doubt change the comparison of costs for a complete heating installation.

At the Aliquippa works, gas-fired infrared radiant heaters were installed at the No. 1 and 2 continuous weld mills of the welded tube dept. The operating people in the buildings are well pleased with the heating system. During the most severe winter weather, at 0 F outside, the indoor temperature is between 55 and 60 F. The men working in the building, however, are comfortable in all parts of the heated portion when moderately dressed with normal indoor winter clothing. This comfort is attained without drafts or blasts of hot air even though the ordinary sheet metal mill building is uninsulated. The Btu output of the heaters is approximately one half what would have been required with blower-type heaters. This experience at Aliquippa agrees with the results obtained described in the article.

Therefore, it is felt that this new type of heater should be given careful consideration on all proposed heating installations. As more of the radiant-type heaters are installed, it will probably be found that this type of heater excels under some conditions and will be found inferior for some conditions.

The control for varying weather conditions is by thermostats at the National Tube installation. At Aliquippa, a manually-set on-and-off time cycle, controlled by clocks, operates zones of heaters for varying outside weather conditions and operating conditions. The use of ignition coils for automatic relighting in case a pilot burner goes out is an added feature. Local conditions, no doubt, dictate the varying details of operation. The initial costs, however, will be effected by these details of the installation.

Perhaps, after more gas-fired radiant heating systems are installed at the steel mills, there may be a set guide to determine the most efficient and satisfactory heating systems for various applications. The proposals described by the author for spot heaters replacing salamanders sound very promising and should be pursued vigorously.

Paul H. Goodell: I would like to re-emphasize the

authors' statement that similar comfort levels appear to be provided with infrared or radiant heating at lower ambient temperature than with convection heating. Extensive tests on this point were made at the University of Cincinnati Medical College in 1935–36 under the supervision of Dr. C. A. Mills. Under nominal rates of physical exertion and identical humidity conditions, hundreds of test subjects reported complete comfort in 54-F ambient temperature when heat was uniformly delivered to the test areas by an overhead radiant heating system. In contrast, similar comfort with convection heating required a mean ambient temperature of 72 F. The explanation for this is that radiation is absorbed by body surfaces at all temperatures whereas convection only serves to insulate or stabilize body heat losses at temperatures up to 98.6 F (normal body temperature).

Comfort levels in most working areas can, therefore, be provided with lower heat input by properly designed radiant systems for the following reasons:

1. Lower building heat loss due to the lower temperature gradient required between indoor and outdoor temperatures for similar comfort levels.

2. The opportunity to zone radiant heating like lighting to correspond with varying needs in specific areas, thus taking advantage of heat losses from furnaces or other high temperature processing equipment and reduced needs in storage areas.

3. In high bay areas (above 15 ft) ceiling or roof losses can be substantially reduced by properly controlled use of radiation at lower elevation with the upper wall surfaces being heated only by gravitational convection derived from radiation absorbed in machinery and the building floor.

Gas-fired radiant heaters are available that provide full venting of the water vapor and other combustion products to the outdoors. These heaters (Figure 4) also assure higher conversion of the input energy to useful long wave-length radiation by enclosing the flame source in a black porcelain enamel heat exchanger to extract heat down to an exhaust temperature of 530 F. At this temperature, heat of vaporization and uncontrolled convection in the combustion products is reduced by approximately 55 per cent as compared with exposed flame heaters designed to operate in the 1500 to 1600-F range.

For most effective comfort heating, radiant energy sources should be located at low mounting height (normally below cranes) to assure exposure of major body surfaces from energy within 40 degrees of the horizontal rather than from vertical radiation which necessarily limits exposure to head and shoulder areas. This is demonstrated by the successful heating of the steel warehouse shown in Figure 5. Installations of this type have been in service for periods up to ten years with very little maintenance required due to the absence of fans, motors and related controls. Fuel economy is necessarily influenced by building construction and is variously reported at 40 to 70 per cent of convection heating costs under similar operating conditions.

J. N. Evans and V. A. Urschel: Further experience at Lorain works during the past winter indicates that much more will have to be written before "comfort" can be confidently engineered into every spot heating installation. The fundamental comfort heating rule, "avoid cold drafts," must be followed. Otherwise it is sometimes necessary to fall back on that even more basic suggestion, "wear more clothes." ▲

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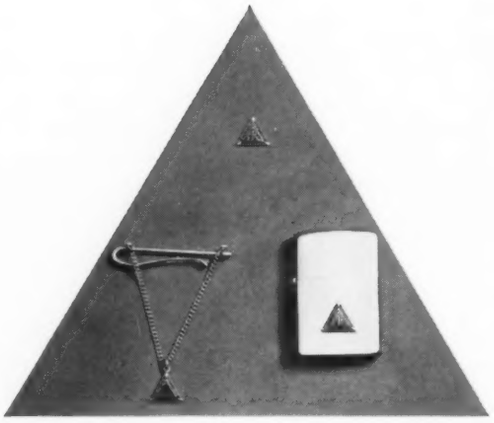


ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building **Pittsburgh 22, Pa.**

minimizing pollution from pickling lines:

automatic control of strip pickling bath composition

Accurate control of the strip pickling bath composition increases pickling efficiency, decreases acid consumption and reduces the amount of waste pickle liquor produced. Thus pollution control is effected by a reduction of waste material rather than by an increase in waste treatment facilities.

by C. W. SHINGLEDECKER, Engineer, Chemical Engineering Div., Research Dept., Bethlehem Steel Co., Bethlehem, Pa.

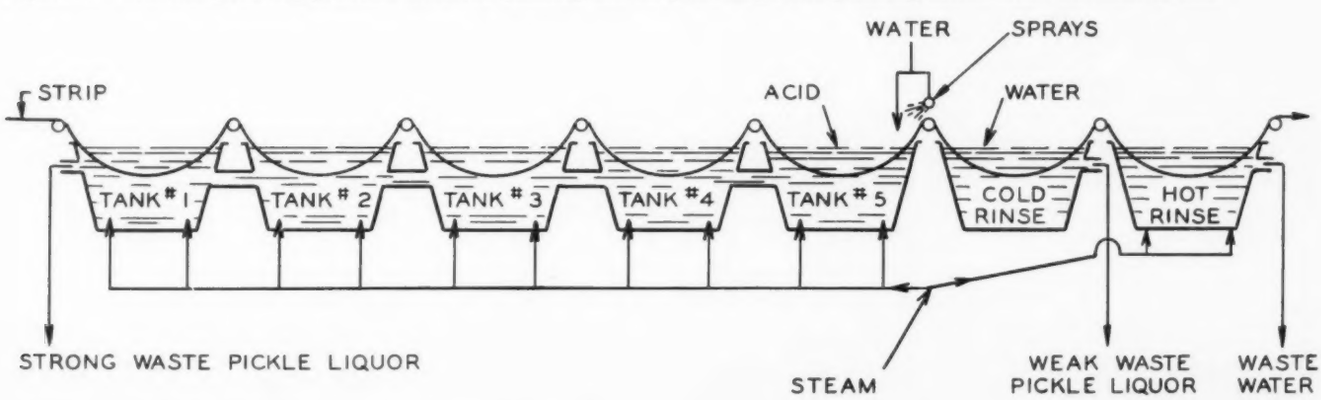
THE steel industry consumes large quantities of acid in various pickling processes, and the disposal of the waste acid from these pickling operations is a serious problem.

Recognizing that one of the important ways to reduce pollution is to minimize the use of acid at the source, the research dept. of Bethlehem Steel Co. cooperated with Sparrows Point plant personnel in studying and setting down in quantitative flowsheet form, the operations of the various pickling units. Material balances were developed for acid, water, steam and iron.

The development of these flowsheets emphasized the fact that the pickling of strip steel consumes the major part of the acid used in all of the pickling operations. Consequently, the research dept. decided to study how to reduce pollution from strip pickling operations, and it is some of the results of this study which are described in this article.

To understand these developments it is well to review briefly the operation of continuous strip picklers. Although there are variations in the manner of operation, normal practice is illustrated in a general way in Figure 1. The strip passes through five pickling tanks, then through a cold rinse tank, followed by a hot rinse tank. In Figure 1 the fresh acid and water are added to the fifth pickling tank, and pickling liquor flows in a direction opposite to that of the strip, through

Figure 1 — Normal pickling practice involved passing the strip through five pickling tanks and two rinse tanks.



the tanks and the cascade piping joining the individual tanks, with the spent liquor overflowing the first tank. The pickling baths are operated at temperatures generally between 200 to 210 F, and the temperature is usually maintained by the introduction of live steam into each of the tanks. In normal operation, baths are analyzed periodically, sometimes at 4-hr intervals, and acid and water, either individually, premixed, or in "proportioned" flow, are added to maintain the bath within predetermined ranges of concentration, ranges which previously have been shown to insure satisfactory pickling. Because of the fluctuations in bath composition which occur between the time that a bath adjustment is made and the time that the next analysis and adjustment is made, the pickling baths are usually maintained at a higher-than-required acid concentration in order to insure the presence of sufficient acid for satisfactory pickling at all times.

The detailed study of strip-pickling operations showed two major defects: as mentioned above, the bath composition fluctuated over a wide range, and also, a substantial quantity of only partially-used acid was being carried out of the pickling tanks into the cold rinse tank and was thereby being wasted. Studies showed that these two defects in operation were causing substantial excess acid consumption.

The problem of dragout was handled efficiently by plant personnel, by installing water sprays and rubber rolls on the discharge end of the pickling tank which squeezed off, and permitted the still-useful pickling solution to flow back into the pickling tank. Subsequently it was found advisable to install a conductivity alarm in the cold rinse tank to warn the operators of the presence of an excessive quantity of acid, indicating improper operation of the drag-out rolls, and thus the necessity for adjusting them.

The other important defect, the occurrence of wide variations in the pickling bath composition, and thus the necessity for using more acid than is actually needed, to make sure that pickling would be of high quality at all times even though the bath composition fluctuated, remained.

Studies of this defect showed that if a uniform composition could be maintained in the last pickling tank (No. 5 of Figure 1) then, with steady operation, the composition of the other tanks would remain constant. Consequently, it would be possible to operate with less acid, to operate with the bath more nearly at the concentration actually needed for pickling, avoiding excessive concentrations which had been used in the past to correct for the lack of uniformity in bath composition. Obviously, with the use of less acid, the spent liquor (overflowing No. 1 tank of Figure 1) would contain less acid. It became clear that by controlling the bath compositions at a constant level, there would be acid savings, more uniform pickling and less pollution.

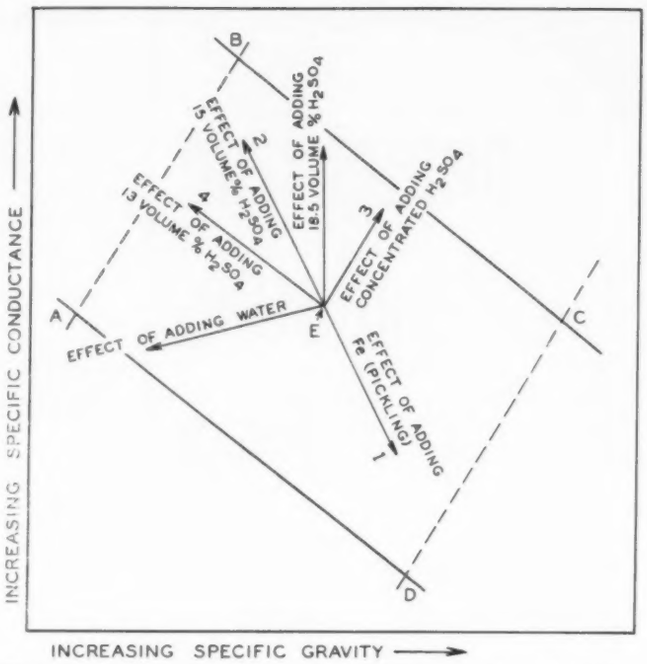


Figure 3 — Vectors indicate the effects of changing the normal pickling solutions.

At this point the problem was discussed with instrument suppliers, to determine what commercial equipment was available for measuring and controlling the acid and iron content of a pickling bath. Although a number had suggestions to offer on individual phases of the problem, none knew how to provide what was considered to be a satisfactory system.

Bethlehem's research laboratory then undertook to study the problem, and it soon became apparent that a specific relationship exists between numerous physical properties of the liquor and its composition. Among these were specific conductance and specific gravity, two properties which, it seemed, should be relatively easy to measure. A detailed study of relationships among specific conductance, specific gravity and composition was made, and some of the laboratory data are shown in Figure 2. While the range of composition shown in the plot is limited to that of interest for one specific pickling operation, data are available on additional compositions which show that the fundamental relationships between the variables still apply. Similarly, plant pickling-bath liquors were found to fall within the pattern of the relationships developed in the laboratory.

In Figure 2, the specific conductance is plotted as the

Figure 2 — Laboratory relationships involving specific gravity, specific conductance and the amount of iron in solution were developed.

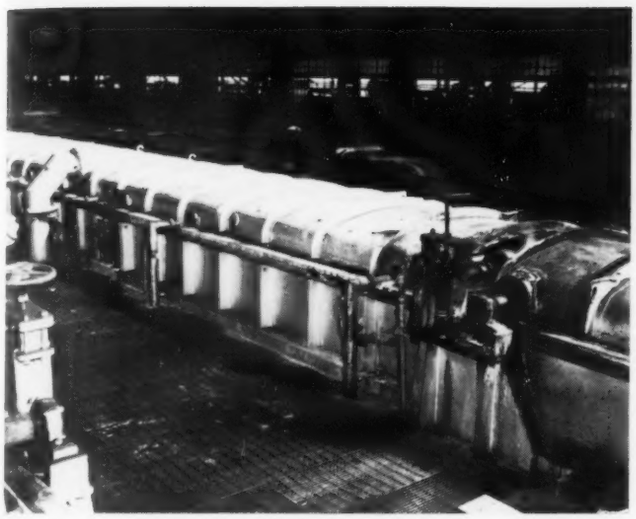


Figure 4 — The pickle tanks are covered and vented to reduce fume concentration.

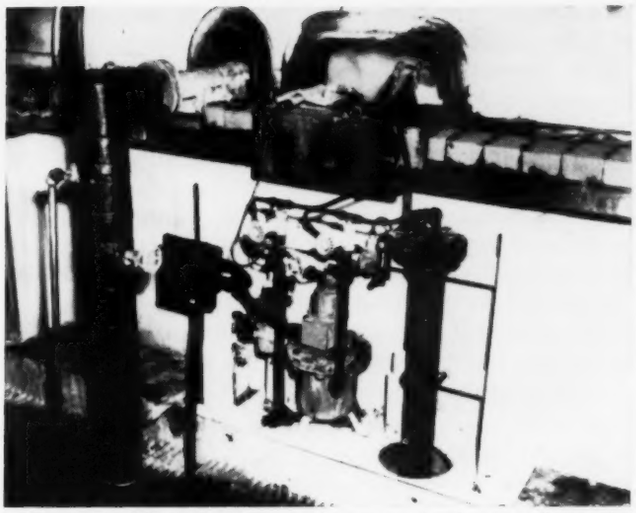


Figure 5 — The sensing devices are best placed at the center of the tank, away from the locations where the acid and water are added.

ordinate, and the specific gravity, the abscissa. The specific conductance is defined as the reciprocal of the resistance in ohms of a column of solution 1 cm long and 1 sq cm in cross section, and is expressed in terms of mhos per cm. The specific gravity, of course, is the ratio of the weight of the solution to that of an equal volume of water. The chart shows a series of constant iron-concentration lines, expressed in lb of Fe per gal, which are almost parallel. Nearly perpendicular to these are a series of constant acid lines, the acid concentration being expressed in volume per cent. The units chosen to express concentrations are those used in the Sparrows Point shops. They can be converted to other units readily. For those more familiar with other units, 12 volume per cent acid is about equivalent to 18 weight per cent, and 0.30 lb of iron per gal is equivalent to about 7.8-per cent ferrous sulphate or 2.9-per cent iron.

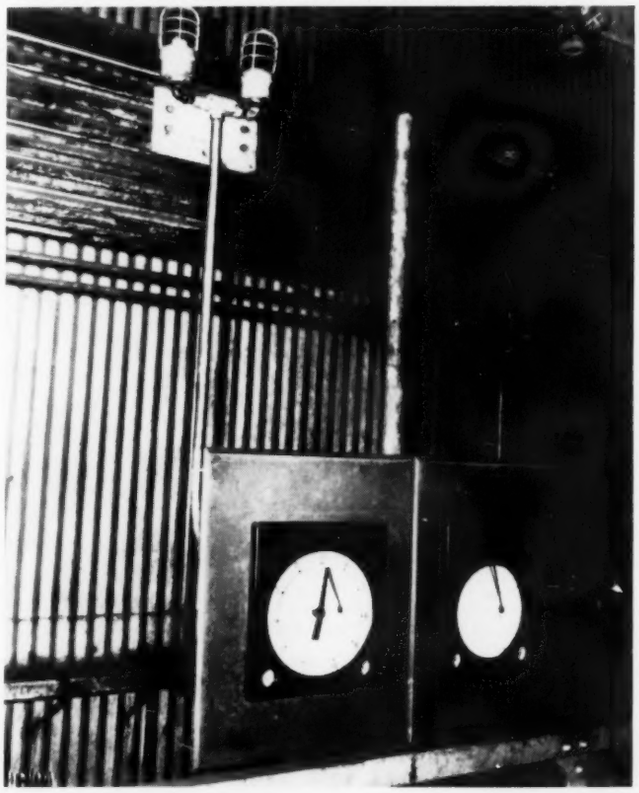
While the data were developed for temperatures of 200 F and above, the same fundamental relationship is applicable at lower temperatures, but below 190 F, the effect of temperature is much more pronounced and may necessitate temperature compensation. However, because in this strip-pickling operation, the bath temperature is held above 190 F, no temperature compensation is used. Figure 2 also shows, of course, that for a given specific conductance and a given specific gravity, there can exist only one iron and one acid concentration. In other words, if one knows the specific gravity and specific conductance of a solution, and has access to the data of the type given in Figure 2, one can immediately determine the composition.

Part of Figure 2 has been shaded to show the area in which one might want to control the bath composition of the last strip pickling tank, that is, tank No. 5 of Figure 1. This shaded area ABCD, has been expanded in Figure 3.

The plotted vectors of Figure 3 indicate the effect of pickling and adding various strength acid to the pickling bath. The intersecting point of the vectors, point E, represents a normal pickling bath. The specific gravity can be read on the abscissa, the specific conductance on the ordinate, and the bath composition from the lines AB, CD, etc. Vector 1 represents the effect of pickling, that is, of adding iron and taking acid away (consuming it). Notice that pickling is accompanied with a decrease in conductivity and an increase in gravity. Also observe the direction of the vectors signifying water and strong-acid additions.

One might think that the best way to counteract the effect of pickling (that is to bring the bath composition back to E) is to make an addition to the bath which will have a vector in Figure 3 which is exactly in the opposite direction to vector 1. Vector 2 is such a vector. In this case it happens that movement in the direction of this vector can be attained by adding 15-per cent acid. However, operating considerations render it impractical to use this exact correction. This is

Figure 6 — Warning lights connected to the recording instruments indicate when the system malfunctions.

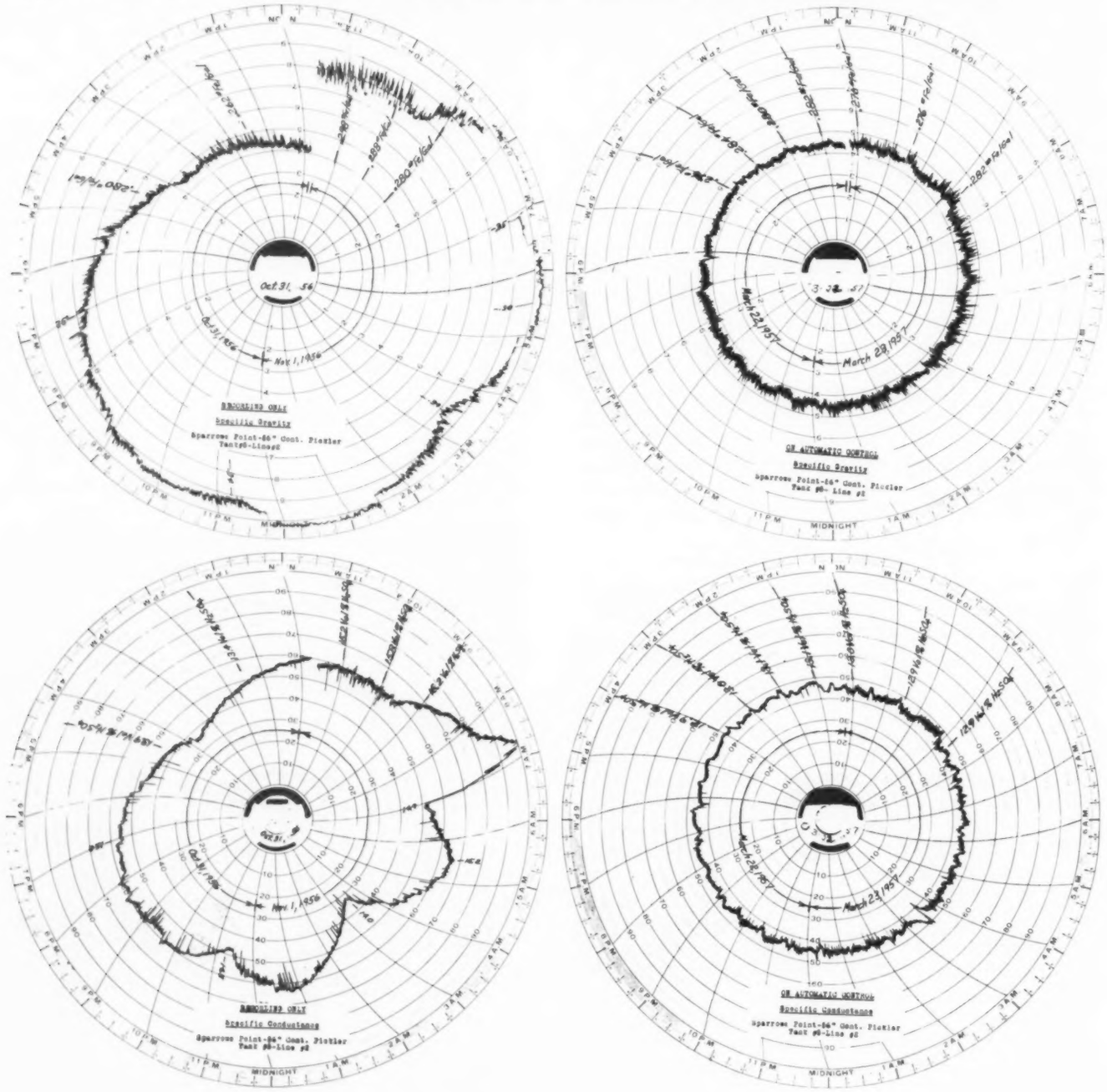


true because one does not always have complete control over steam and rinse water additions to the pickling tanks. Consequently, it has been found that the best method for counteracting the effect of pickling is to use two additions, the addition of strong acid (vector 3) and an acid of about the same concentration as the pickling bath, vector 4. In using these two additions for controlling the pickling bath composition, the addition of strong acid can be controlled by the measurement of conductivity, and the addition of dilute acid by the specific gravity measurement.

In controlling the bath, the instruments would be set at predetermined specific gravity and specific conductance values, corresponding to the desired bath composition, such as E of Figure 3. The control equipment then automatically regulates concentrated acid additions to maintain the desired specific conductance, and dilute acid additions to hold the specific gravity at the desired value. In this case the dilute acid additions are actually achieved by introducing concentrated acid and water in proportioned flow.

After the control principle had been developed in the laboratory, instrument suppliers were consulted once again, and suitable sensing devices and control equipment, which are now commercially-available stocked items, were selected for the first trial at the plant. The control scheme was first installed on one of the continuous strip pickling lines at Sparrows Point, in

Figure 7 — The charts indicate that the control system is able to maintain parameters within a narrow range.



BEFORE CONTROLS

AFTER CONTROLS

September, 1956, and was initially used for recording bath characteristics on an around-the-clock basis for about four months.

A portion of the strip pickling line on which the first control system was tried is shown in Figure 4, about two thirds of the last pickling tank (No. 5) and a small portion of the cold rinse tank are shown. The vent exhaust piping, which is mounted on the tank cover at the center of the 60-ft pickling tank, may be seen in the left center of the photograph. The sensing devices are mounted on the side of the tank, just to the right of the vent piping.

A close-up view of the sensing devices is shown in Figure 5, from which it is apparent that they do not require much space. The header for supplying steam for heating the bath is shown near the sensing units. Normally, the live steam would not be introduced into the pickling tank near the sensing elements, but in this case, because both sensing units and the steam outlet are separately recessed in the side wall of the pickling tank, it is possible to have them close together. Nevertheless, as a general rule, the sensing devices should be installed on the side of the pickling tank near the center, at a location remote from the location where live steam, acid and water are introduced.

The conductivity and specific gravity recorder-controllers for the first test line are shown in Figure 6. These instruments not only record the conductivity and specific gravity of the pickling bath, but also they control the addition of strong and weak acid. They were mounted near the pickling tanks in the first installation, but control units for additional lines are now being installed in control rooms, which, in some cases, are more than 500 ft away from the tank being controlled. Figure 6 also shows, above the recorders, the red and green-light alarm system, the red announcing mal-operation.

The development of this system of bath control was carried out in a cautious manner. As previously mentioned, for the first four months, the instruments were used for recording only, in effect, for continuously analyzing the bath. Data obtained during this period confirmed the prior laboratory data and showed that the sensing and recording instruments were performing satisfactorily. However, during this period, the hot pickling solution was found to be extremely corrosive, and considerable trouble with materials of construction was encountered. Consequently, along with testing the sensing devices, some 25 corrosion samples were also tested by immersion in the pickling bath, and from the results of this testing, suitable materials of construction were selected which have been in operation for some time and are still good.

After the recording-only period, the system was tested by automatically controlling the bath composition on a part-time basis. By March, 1957, operating and research personnel had gained enough confidence in the system and the pickling operators were sufficiently familiarized with it, so that automatic control of the bath composition was undertaken, and has, since then, been used whenever pickling operations are scheduled on this line.

The system has proved to be very satisfactory: pickling is more uniform, less acid is consumed and there is less potential pollutant produced.

The success of holding bath composition uniform is well illustrated by the recording charts of Figure 7, which show the extreme variations in bath characteristics before adopting automatic control, and the uniform condition which exists after adopting it. It is of interest to note that the wide fluctuations in bath composition which had been encountered before, occurred despite the use of acid-concentration proportioning equipment which controlled the continuous addition of acid and water. Of particular interest is the fact that it has actually been found that the variations in the controlled bath composition are considerably less than the variations which different pickling plant operators report when they analyze the same sample.

The usefulness of this control system is demonstrated by the fact that acid consumption has dropped 10 to 25 per cent, and that the saving in acid amortizes the cost of control equipment in less than a year. There is, of course, an additional saving because there is less waste pickle liquor to be disposed of. Another indication of the value of the system is reflected in the fact that the Sparrows Point plant is now using similar equipment on three other strip-pickling lines, and that they are now similarly equipping the remaining three strip-pickling lines, which will bring the number of lines equipped in this manner to seven. The Lackawanna plant has recently put a similar unit into operation, and they expect to equip the remaining two lines.

Discussion

PRESENTED BY

WILLIAM J. O'DONNELL, General Foreman, Cold Strip Mill, Cleveland Works Div., Jones & Laughlin Steel Corp., Cleveland, Ohio

C. W. SHINGLEDECKER, Engineer, Chemical Engineering Div., Research Dept., Bethlehem Steel Co., Bethlehem, Pa.

DR. I-KUEN YEN, Crucible Steel Co. of America, Pittsburgh, Pa.

DR. T. A. McLAUCHLAN, Supervising Technologist, Electromechanical Engineering Div., Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

William J. O'Donnell: A statement was made by the author which indicated that there was a considerable savings in acid consumption under this new system. How close was the supervision on the lines prior to installing this system?

Also, what was the acid consumption, what is it now and what is the iron and acid overflow?

C. W. Shingledecker: Under the old system, there was one pickling inspector for two lines. He used acid-concentration proportioning equipment to control the continuous addition of acid and water to the pickling baths. After analyzing all of the pickling baths every four hr, the proportioning instruments were reset in an

effort to obtain a more desirable pickling bath composition.

There are many variables in continuous strip pickling operations that have an influence on the quantity of acid consumed. A few of these variables are thickness and width of the sheet, the type of scale, size of coils, size of piping between the pickling tanks, degree of acid carry-over from the pickling tanks to the rinse tank, frequency of dumping a pickling line to repair tanks and extent of descaling prior to pickling. At Sparrows Point acid consumption has been reduced by about 20 per cent by the proper use of the controls. In the future, it is felt there will be further reductions through the use of better descaling methods prior to pickling and the treatment of larger coils. The installation of this control system on any existing continuous strip pickling line should cause a reduction in acid consumption.

The acid and iron concentration in the overflow from the first tank is also influenced by many variables. The size of the cascade piping between the pickling tanks is one factor which governs the spread in compositions in the individual tanks. This spread in composition should be regulated to provide good pickling in most of the tanks and still produce a sufficiently spent overflow from the first tank. One of the pickling lines using the control system regularly produces an overflow from the No. 1 tank analyzing about four to five volume per cent of acid which is equivalent to six or seven weight per cent of acid. The iron in this overflow is about 0.7 lb of iron per gal, equivalent to about seven per cent Fe or about 18 per cent ferrous sulfate.

Dr. I-Kuen Yen: Some work has been done at Crucible research on the specific gravity-specific conductivity measurement of H_2SO_4 pickle liquor. This work was mainly for analytical purposes.

Nickel and chromium are present in the acid solutions used to pickle stainless steels. Moderate amounts of these elements do not affect the readings from the nomograph if the Fe, Ni and Cr are reported together as grams of metal per liter of solution.

Some of the nomographs available in the literature are not very accurate. Two nomographs similar to the author's Figure 2 were constructed. One nomograph at 140 F covers a range of 0 to 70 grams per liter of metals and 6 to 20 per cent free H_2SO_4. It has an accuracy within plus and minus eight per cent when compared to the chemical analysis. It should be stressed that these analyses were done last and double checked. The second nomograph at 80 F covers a narrower range and has an accuracy of only ± 20 per cent.

Dr. T. A. McLauchlan: Referring to Figure 3 of the author's article, and looking at the control system from a purely academic point of view, it appears that the controlled inputs to the pickle tanks should be 18.5 volume per cent of sulphuric acid and approximately three volume per cent of sulphuric acid. The 18.5 volume per cent of sulphuric acid could only affect specific conductance in the bath, and the three volume per cent of sulphuric acid could only affect specific gravity. There would be no interaction between the two effects. In the present application, any advantage in control that could be gained by this modification would be very slight and no doubt would be offset by the complication of having to premix the stronger acid in addition to the weaker acid.

Concerning the problem of the installation of a control system on a pickle line, it is well known by mill personnel that control or other mechanisms in the vicinity of pickle lines do not generally behave satisfactorily. Consequently, if a control system is to be installed, great care must be taken in the engineering and in the installation design to minimize corrosion and to ensure maintenance-free operation.

Figure 7 shows that a marked improvement was obtained with the automatic control as compared to the original manual control. To be valid, this comparison should consider possible improvements to the manual control system. Such improvements are often indicated by an automatic control study. In some United States Steel mills an improved manual control for pickle liquor is used that consists of making bath additions continuously and adjusting the flow rates every two hr on the basis of laboratory analysis of the bath contents. Under these conditions it appears that the measured quantities in the bath (acidity and iron content) can be maintained to within approximately ± 10 per cent of their preset values. There is no doubt that an automatic control system for the pickle liquor could improve this performance, but the advantage to be gained in this case is more limited than in the original comparison. In view of this, it becomes even more important that the proper precautions be taken to eliminate maintenance and reliability problems.

Member: The author's article is a very good illustration of the practical application of some fundamental principles of good waste control. Pollution is becoming more important and is being emphasized by regulatory agencies as well as the general public. While one may not agree with specific goals of a particular control program, one must agree with the ultimate goal. When it is considered that industrial usage of water is expected to increase by 170 per cent by 1975, conservation of water quality for all uses becomes a reality which must be considered.

Pollution control has not been readily accepted in many areas. This is to be expected, because in many instances waste treatment facilities produced no monetary returns on the money expended for construction and operation of the facilities. This need not always be true, for if pollution control is considered an integral part of facilities of water in the plant, a properly conducted program in addition to supplying, means a saving by better control on operation, improvement of water quality and subsequent reduction of maintenance cost and downtime and better use of product.

The solution to the problem discussed in this article illustrates the application of these fundamental purposes.

The problem is defined by actual study where the waste originated and the volume involved. This defines the area where the larger savings could be effected.

Instead of treating the waste, another fundamental approach was investigated; that is, means of reducing the amount of waste. Waste treatment costs are similar to any other operating cost, and if they can be reduced substantial savings accrue, not only in first cost but in operating cost.

The controls, given a pilot plant testing as to conductivity and specific gravity measurements, were used for some four months only to check the management control. This is an essential step and there are other methods of control that can be employed. When substantial savings are realized by reduction of wastes and at the same time you effect a reduction in the amount of materials used and create no production problems you indeed have a happy solution.

Since these devices usually give considerable trouble, whether they are used to measure waste characteristics or even water, does this pose an operating problem, and what materials were found best?

Also does the evolution coming back into the tank cause erratic reading and control?

How does the free acid content in the rinse tanks compare with 4½ of the installation system?

It appears savings can be carried one step further by using the rinse tank water as dilute acid makeup. Was this considered, and is there any practical reason why it could not be done?

Were temperatures under operating conditions a significant factor, or were they controlled within limits which were indicated in the article as having no affect?

Did actual operating conditions, such as variation of speed and condition of strip, cause any particular operating difficulty?

How did the composition of tank No. 5 or the control tank compare with each of the other tanks? Was any comparison made before or after the installation of the control system on variation of these tanks?

Also has any consideration been given to control of the amount of acid now discharged so the minimum of free acid and maximum of iron is discharged perhaps by installing additional controls on the first tank instead of the last?

C. W. Shingledecker: Two sensing devices are immersed in the pickling bath. An air bubbler system is used for specific gravity measurement and a cell is used for conductivity measurement. It was found that antimony lead was a suitable material of construction for the air bubbler tubes, which are very simply designed. The bubblers have to be replaced about every six months to one year. Still better materials could be used, such as tantalum, but it is doubted that the extended service life would justify the added cost.

For the conductivity-sensing device, plastic cells mounted in antimony-lead holders were used. This arrangement did present some problems due to the presence of oil on coils that are repickled. After the strip passes through the pickling tanks it is recoiled in a bath containing mineral or vegetable oil, and occasionally these coils require repickling. These oils which contaminated the pickling baths would stick to the plastic cell and render it less effective. This problem was solved by substituting a glass cell for the plastic cell. At first, it was thought that a glass cell would be entirely too fragile for use in a pickling line. The glass cell is held with neoprene tubing and mounted loosely in the tank. It has been found that breakage of the glass cell in the pickling bath has been no problem, and that very little oil sticks to the glass. Nevertheless, when coils are repickled, the cell requires cleaning about once every eight hr. Cleaning of the cell is a very simple procedure, involving only removal of the cell from the bath and immersion in a cleaning solution for a few min.

There was very little change in the free acid content in the rinse tank resulting from the installation of the control system. The amount of acid in the rinse tank is governed more by the operation of the drag-out roll than it is by the automatic control. If the drag-out rolls are not set properly, there could be a considerable amount of acid carried over into the rinse tank, regardless of how the automatic controls are set. So the amount of acid in the rinse tank is not directly related to the use of automatic bath controls.

Variations in temperatures under operating conditions were not a significant factor in the performance of the control systems. Pickling occurs faster at the higher temperatures; therefore, the baths are nearly always held at a temperature between 200 and 210 F. For some steels, the pickling bath temperature is lowered to 190 F and the controls still function properly. There was no need for temperature compensation, since temperature had so little effect on the conductivity and specific gravity in the control range.

Variations in operating conditions, such as speed and condition of strip did not cause any difficulty in operating the control system. The control does not care whether the line is operating, or at what speed the strip passes through the tanks. The system is based on the observed fact that for a given specific gravity and conductivity, a pickling solution can have only one iron content and one free-acid content, and the control holds the bath at one composition. If the line stops for a while and there is no change in bath composition, the controls will close the acid and water feed valves.

A comparison was made before and after the installation of the control system on the variation in bath composition in the individual tanks comprising a pickling line. It was found that the compositions in all of the tanks were more uniform after the control system was installed. By maintaining a uniform composition in tank No. 5, the composition in the other tanks will be more uniform, and the spent liquor overflowing tank No. 1 will have a constant composition.

Using the water from the rinse tank, which contains some acid, for make-up water to the pickling tanks was considered. In most of the operations, the volume of this rinse water is many times that which would be required for bath dilution purposes, so only a small part of it could be used.

The installation of controls on the first tank to regulate the composition of spent pickle liquor, rather than controlling the composition in the last tank, may work; but this would involve measuring the compositions in tank No. 1, and trying to control the strength in tank No. 5. Because the five tanks represent a process lag of approximately 50,000 gal, it might be a little difficult to control in that manner. At Lackawanna the control scheme was modified slightly in that the No. 4 tank of a 5-tank pickling line contains the strongest acid concentration and the controls have been installed in this tank. This system has operated satisfactorily. It is believed, that by controlling the composition in tank No. 4 or No. 5, the spent liquor overflowing tank No. 1 will have a fairly uniform composition, and that the best interests of increased production and pollution abatement will be served. ▲

The Design of Coolant Systems as affected by various cold rolled products

by J. PHILIP WETTACH, Manager, Mill Lubrication,
Engineering and Construction Dept., Dravo Corp., Pittsburgh, Pa.

. . . . with the trend toward higher mill speeds, greater reductions and better strip finishes, centralized lubrication and coolant systems must be installed to permit the flow volumes and improved filtration necessary . . . .

TODAY the wide range of products being rolled in the steel industry require many variations in rolling equipment and methods of operation. Among the list of equipment affected is the central coolant system used in cold rolling operations.

The basic types of central systems used in the industry, showing variations involved with different products are outlined. In order to better visualize the differences between the typical systems, simplified schematic flow sheets are presented.

Improvements in the design of coolant systems used in the aluminum industry are mentioned to illustrate the possibilities of advancement that exist in the field of central coolant systems.

SOLUBLE OIL SYSTEMS FOR COLD ROLLING SILICON, CARBON AND STAINLESS STEEL STRIP

The soluble oil system uses as a coolant a soluble oil emulsion ranging from 3 to 20-per cent soluble oil in water. These solutions may contain mineral oils, palm oil, or other fatty lubricants and various quantities of some emulsifiers or special soluble oils. The soluble oil system is usually exposed to tramp oil contamination; therefore, it is desirable to use an emulsifying agent which will not allow the tramp oil to go into solution. In this system the tramp oil that rises to the top is removed by skimming devices, eliminating such undesirable effects as staining the strip during rolling or causing difficulties in the cleaning operation. Tramp oil should be removed continuously either by a mechanical apparatus, or by an air skimming device, which has proved successful on many installations.

This oil, along with a portion of the soluble oil that would overflow the adjustable skimming weir, is then centrifuged for resale to an oil reclaimer or used in low-grade requirements in the plant. In Figure 1 a desirable condition is illustrated where the coolant from the mill pan returns to a sump tank before being pumped to the main storage reservoir. Using this method rather than the usual gravity return to the main reservoir, it is possible to place a roughing filter in the main return to the reservoir. This filter, of the automatic continuously back-washing type, will remove contamination down to 0.0025 in. in size. This eliminates a large portion of the heavier particles that would normally settle out in the reservoir, and lengthens the time between reservoir cleaning operations. With major contamination removed from the oil before it returns to the reservoir, the final polishing filtration is done with the use of cartridge-type filters removing particles down to ten microns in size by the full-flow method before application on the mill.

Since the roughing filter is completely automatic and removes the bulk of the contamination, this lengthens the time between cartridge changes on the polishing filters.

In order to maintain a constant spray pattern on the rolls and strip, it is necessary to have constant pressure and temperature at the mill. All coolant systems should

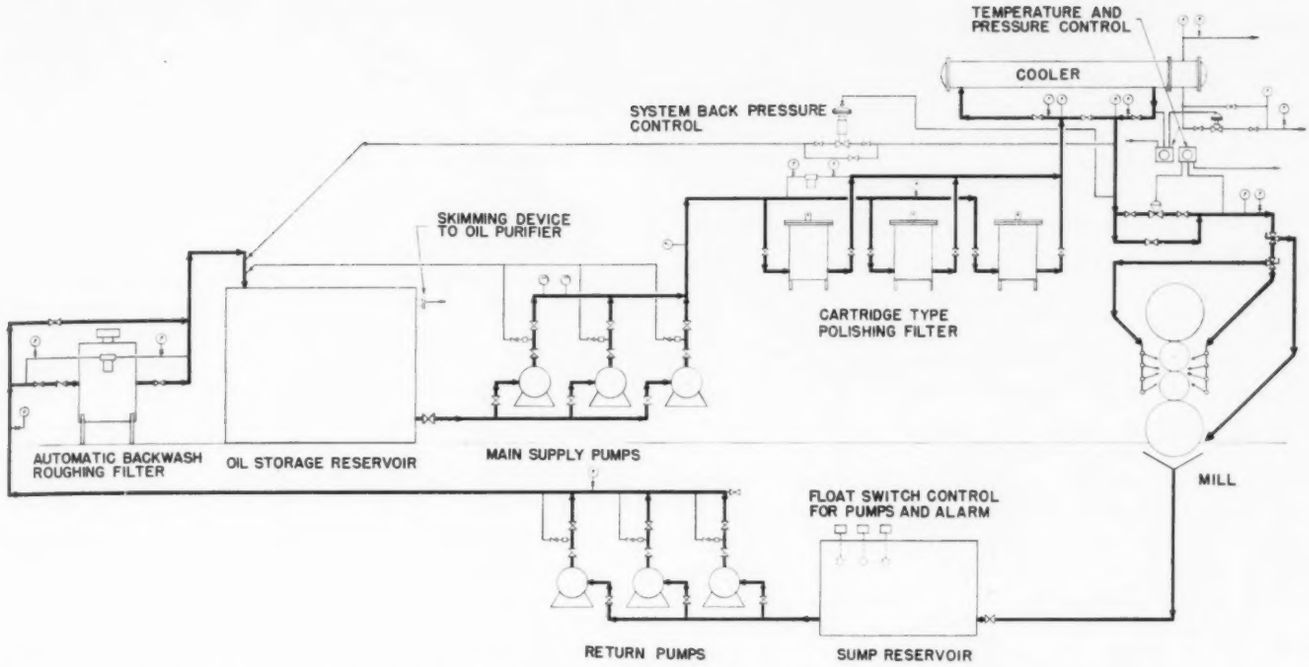


Figure 1 — The use of a sump tank permits the placement of a roughing filter in the reservoir return line.

be designed with this in mind. As shown in the installation in Figure 1, an automatic pressure control is placed as close to the mill as possible to compensate for pressure drop in the filters, heat exchanger and piping. If the pressure desired at the sprays is 100 psi, the system would be designed with a pump discharge pressure of 175 psi; thus, with a 15-psi drop through the cooler, a 30-psi drop through the filters and a 10-psi drop through the pipe fittings and valves, the pressure drop across the pressure control valve would still be 20 psi, giving the desired 100-psi pressure at the mill. However, since all these pressure drops vary from time to time, especially in the case of the filters, it is necessary to have a pressure controller to maintain a constant spray pattern at the mill.

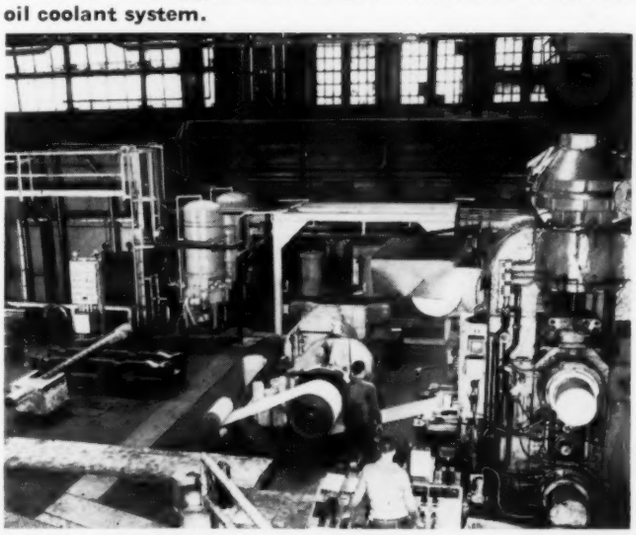
Since the mill shown in Figure 1 is a reversing mill, the operator should have the option of diverting the flow from one side to the other and also diverting the entire flow to the mill pan for threading or changing rolls.

The heat exchanger used to cool the oil is usually of the shell and tube type with the oil passing through the shell side and the cooling water through the tubes. The cooler is designed to remove 60 to 75 per cent of the heat load generated in the rolling operation based on the horsepower of the mill drive. The remaining heat is dissipated by such factors as radiation and transmission losses. The coolant system capacity in gpm is also determined on this basis. Thus, a single-stand mill with a drive motor of 1300 hp (figuring 75 per cent of the horsepower for heat load) can develop a heat load of 2,486,250 Btu per hr. The capacity of the system in gpm can vary, depending upon temperature drop across the cooler. The formula for system capacity would be: gpm = Btu per hr/(temperature differential × coolant constant). The coolant constant is a factor of the weight of the liquid times the specific heat times the specific gravity. In the above example, using mineral oil as a coolant, the system capacity would be 1200 gpm with a 10-F temperature drop across the cooler or 600 gpm with a 20-F temperature drop across the cooler. The circulating capacity of the same system using soluble oil and water would be 525 gpm with a 10-F drop or 262 gpm with a 20-F drop.

This method of determining coolant system capacity is generally accepted although there are many other factors involving capacity depending upon the product being rolled, the type of mill and the general experience of the mill operators.

The mention of mineral oil is made with reference to this schematic because a mineral oil system used in cold rolling steel (Figure 2) would be very similar in design. There are numerous installations of dual coolant systems, using the same general type of design, being

Figure 2 — The mill is designed for cold rolling stainless steel and is equipped with a dual mineral oil and soluble oil coolant system.



placed on a single mill, thus giving greater freedom in use of coolant for the products being rolled. On mineral oil systems exposed to the possibilities of oxidation of the oil, it would be necessary to add additional filtering of the Fuller's earth type to adsorb the undesirable oxidation contaminants.

TIN-PLATE, BLACK-PLATE COOLANT SYSTEM—DIRECT APPLICATION

A coolant system for use on a tandem cold mill rolling tin plate or black plate varies greatly from the central recirculating-type coolant system just discussed. The purpose of the coolant system, of course, is to remove excess heat developed during the rolling operation, lubricate the strip and rolls and clean the product as it is being rolled. In the direct application method shown in Figure 3, the cooling medium (plain water) is applied to the rolls and strip, while the lubricant (palm oil or palm oil replacement) is applied separately. Filtered water is applied at pressures varying from 150 to 250 psi, usually on the entry and delivery side of each stand. The arrangement of spray headers and nozzles vary greatly with each mill so that no attempt has been made to show a standard-type spray arrangement. Roll shape is controlled by sectionalizing the water spray headers.

The palm oil, or fatted oil, is a solid at room temperatures; therefore, it is necessary to heat the oil to from 130 to 150 F in a holding reservoir so that it can be pumped and properly mixed with a small quantity of water. The initial mixing of the oil and water solution varies from one part oil to three parts water to one part oil to ten parts water. The proportioning is done by a proportioning pump supplying the palm oil and hot water to a mixing tank prior to application on the mill. The schematic shows one palm oil mixing system although tandem mills such as the 5-stand mill shown would require two systems. This would permit a richer mixture for application to the steel as it progresses through the mill. The oil may or may not be applied to the first stand, depending on the lubricant existing on the strip as it comes to the mill.

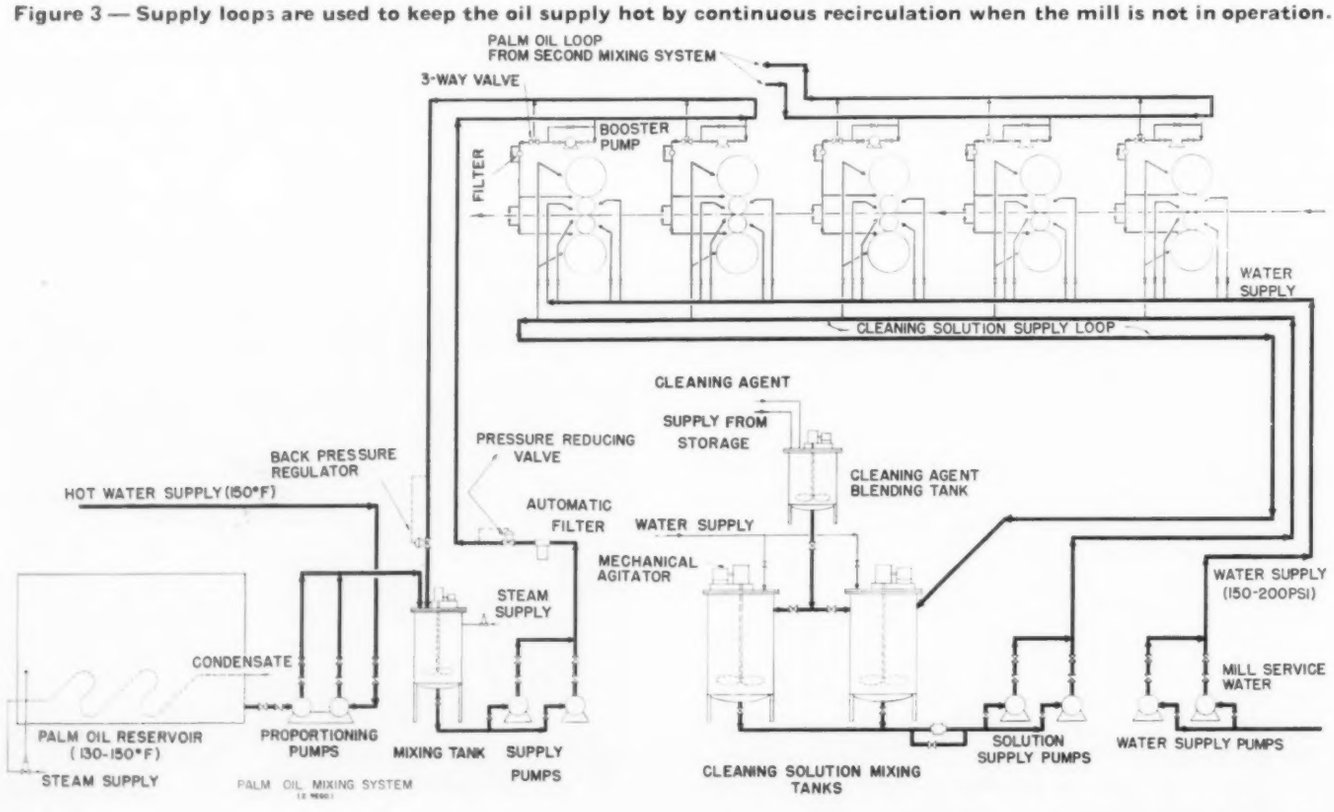
In some installations the oil and water are metered into the suction of a small centrifugal pump located individually at each stand. The pumping action in this case is used in place of the oil mixing station.

To keep the oil and water solution hot during the operation of the mill, it is necessary to loop the oil application supply so that, whether the oil sprays are being used or not, the solution is continually flowing through the lines back to the mixing tank where it is reheated and continuously agitated. The recirculation capacity is rated above the mill requirements. A booster pump located at the mill will keep the solution in motion in the branch lines to the individual mill stands. A remotely-operated, 3-way, 2-port valve will direct the flow of oil either to spray or back to the return header.

As in the case of the water spray headers, the location of the oil application headers depends on the mill operator. In the schematic, the oil is shown being applied between the backup rolls and the work rolls, thus carrying it around into the bite on each individual stand. In addition, application is made at the delivery side of each stand to permit the oil to cover uniformly the strip prior to entering the next stand.

Automatic edge-type filtration of the solution takes place at the discharge of the main supply pumps, and another filtering element is located at each individual stand. This system, in order to function properly, must have the necessary pressure-reducing valves and back pressure regulators as shown.

Figure 3 — Supply loops are used to keep the oil supply hot by continuous recirculation when the mill is not in operation.



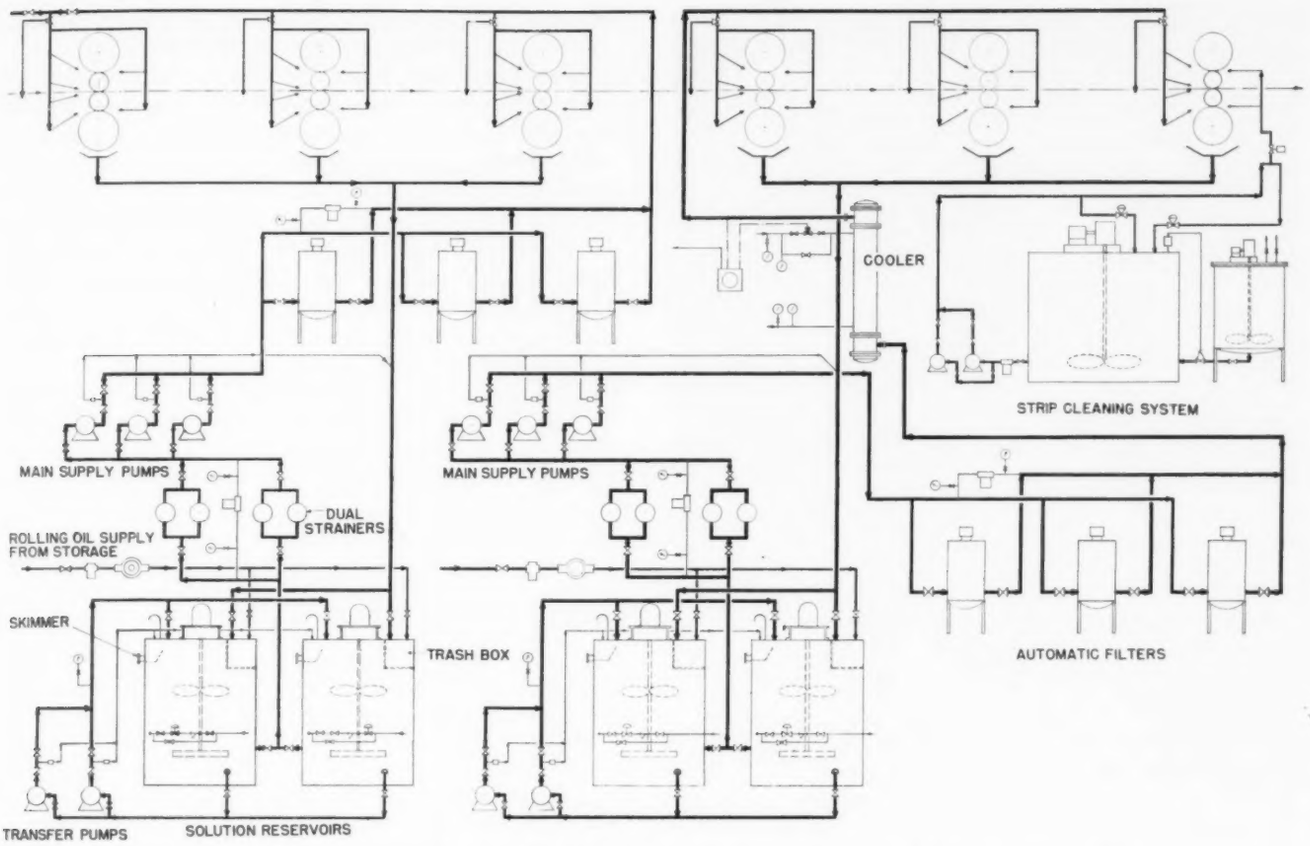


Figure 4 — Proper filtration and the use of stand-by filtration units assures a supply of clean rolling oil.

Corrosion-resistant piping is used in the oil loop to minimize the danger of scale developing in the lines and spray nozzles. Provision is also made to steam flush the loop during periods of mill shutdown to eliminate the possibility of clogging the lines with solidified oil.

Also incorporated into the system is a method of cleaning the strip during the rolling of black plate. In this design various cleaning agents are mixed in the blending tank before advancing to another mixing tank. There, a solution of water and cleaning agent (i.e., mineral spirits with varying detergent qualities) is mixed.

The final solution that would be applied to the mill, rolls and strip would be approximately one part cleaning agent to six to ten parts water.

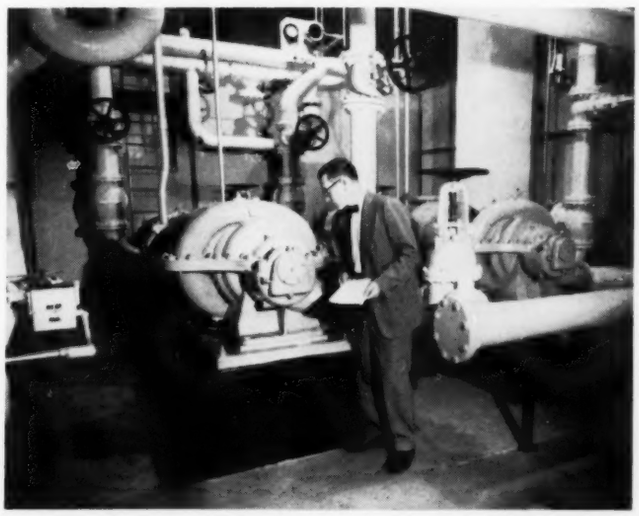
Basically, then, this system would use palm oil or a fatted oil and water when rolling tin plate, and would employ the cleaning solution and water for rolling black plate.

TIN-PLATE COOLANT SYSTEM— RECIRCULATING SOLUTION TYPE

In central recirculating coolant system, shown in Figure 4, the oil and water mixture are applied from the same spray header rather than from two separate headers as in the direct application method. The solution is made up of a fatted rolling oil and water. Again, the rolling oil is solid at room temperature; thus the oil must be heated to be pumped. It is then mixed with water at a temperature of 130 to 150 F and kept constantly agitated while in use. As in the direct application method, the desire is to have the oil adhere uniformly to the strip, or rolls, at the roll bite; the ability of the oil to do this is referred to as "pop out." The low rolling oil emulsion content permits a separation of tramp oil from the rolling solution. In this type of solution system, it is necessary to skim the tramp oil and entrained contamination from the top of the reservoir. Water can be added to the main storage reservoir from time to time, raising the level to the fixed overflow and thus skimming undesirable tramp oil and contamination from the solution.

In the solution-type system, the problem of filtering is much more difficult than with straight mineral oil coolants or complete soluble oil and water coolants.

Figure 5 — Large centrifugal pumps are used to force the coolant supply to the mill sprays.



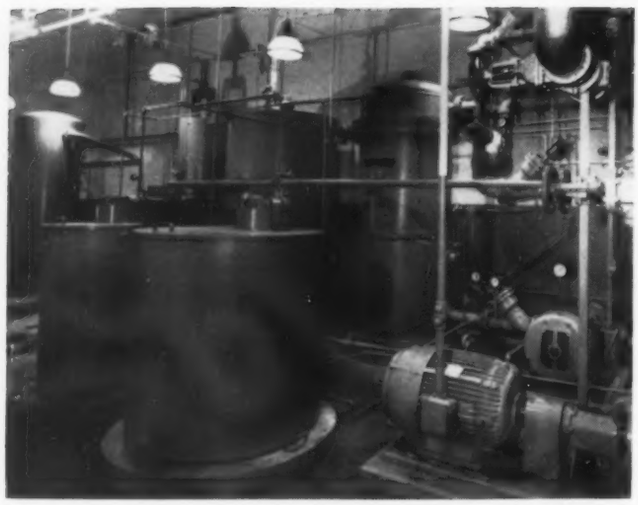


Figure 6 — An automatic diatomaceous earth—Fuller's earth filtration system is illustrated.

Trash screens are located in the reservoir at the return connection from the mill to remove large particles that find their way into the mill pan. Finer screening takes place at the pump suction strainers. Strainers of the double-basket type, which permit cleaning of one basket while the flow is diverted through the opposing basket, are often used. Straining oil with a basket mesh down to 0.02 to 0.015-in. spacing will protect the centrifugal pumps. The main and spare pumps of a typical installation are shown in Figure 5. Relief orifices are employed to permit sufficient quantity of coolant solution to pass through the pump even though they might be running against dead shutoff, eliminating the danger of overheating and damaging the pump or impeller.

The main filtering units are of the continuously-cleaned edge type with 0.012-in. spacing. It is desirable to have main and spare filtering units to insure continuous filtration of the coolant during maintenance periods on the filter.

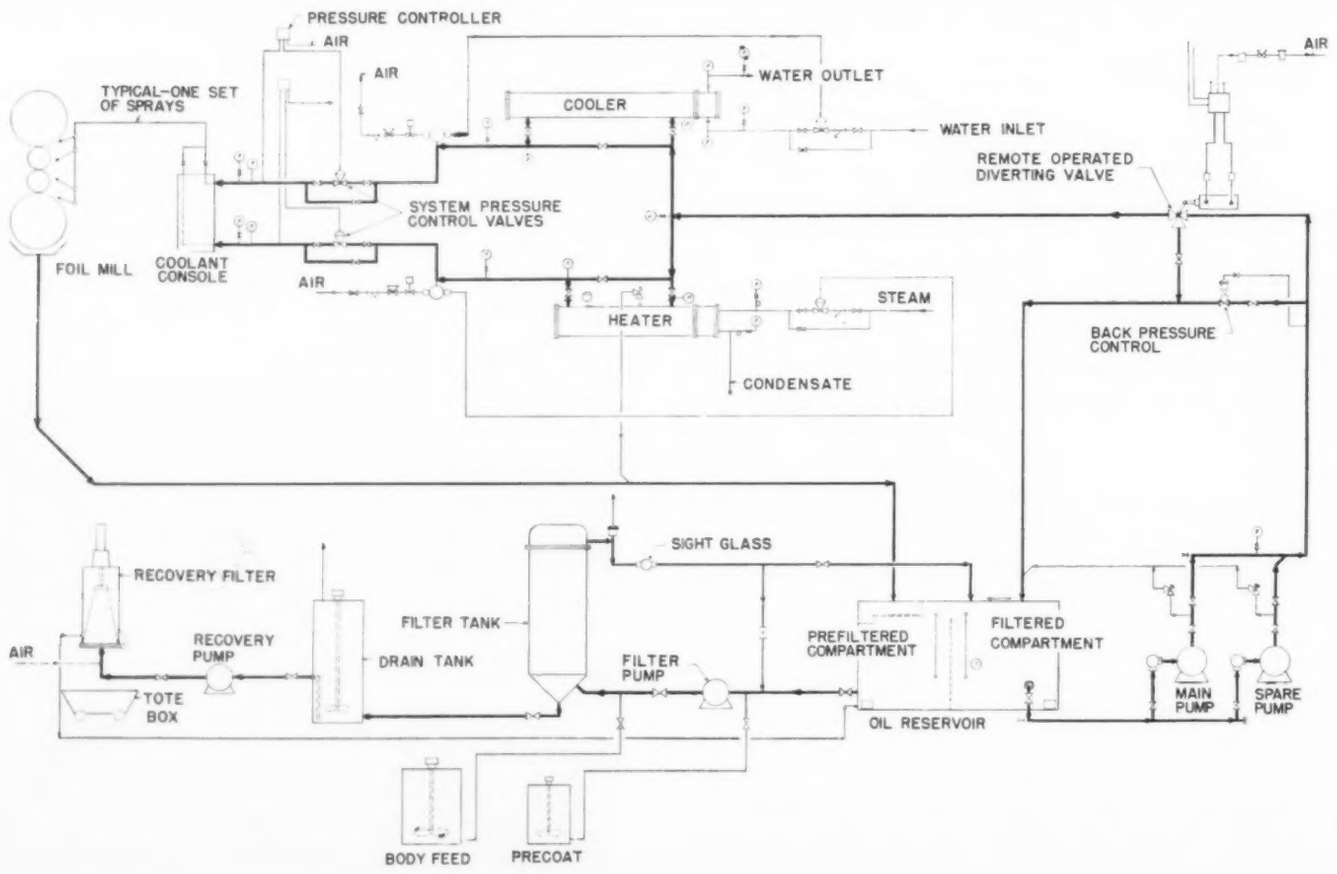
As is the case in all coolant systems, it is necessary to have differential pressure switches across strainers and filters to warn of high differential pressure so that necessary corrections can be made. Many other alarms such as high and low level in the reservoir, high and low temperature and low pressure are desirable.

The control of the spray nozzles at the mill varies, of course, with the allowable tolerance in the product being rolled. This might mean that some spray headers can be installed with no individual nozzle control for roll contour. Others have as many as three sections; still others have individual controls on each spray nozzle which might be spaced as close as $1\frac{1}{2}$ to 2 in. apart.

The method of diverting the flow at the mill also varies. In most coolant systems, large capacity centrifugal pumps are used, and if the system is properly designed it is possible to shut off the individual stands and run the pumps against tight shutoff. The method of coolant supply control to individual stands is shown as a remotely-operated 3-way valve, thus dumping the entire flow of oil to the mill pan. This has a tendency to flush the mill pan and keep it free of contamination or build-up.

Mills with a product mix which requires production of a light gage sheet or black plate might require a strip

Figure 7 — In order to obtain a high degree of filtration, it is necessary to filter up to 110 per cent of the oil supply required.



cleaning system to be used in conjunction with the main coolant solution system. This cleaning operation takes place in the final stand, as shown on the schematic. As is the case in the schematic of the direct application mill, the cleaning medium used is a water solution of mineral spirits with varying detergent qualities. This cleaning system would be in continuous operation when used as shown. A direct application of straight mineral spirits is also used for cleaning rolls and is usually a pushbutton operation so that a shot of cleaning agent can be applied to the individual mill stands as needed.

DIATOMACEOUS-FULLER'S EARTH PRECOAT FILTRATION

As has already been indicated, filtration is one of the most important phases of a central coolant system. The desired results of the coolant system can only be as effective as the filtration used.

In selecting the proper filter for the coolant system, it is important to know the minimum particle size that can be tolerated so that the filter will not be sized to remove particles smaller than necessary from the coolant, thus reducing costs for which there is no return. As an example, on many installations an automatically cleaned mechanical filter which removes particles down to 0.005 in. in size is used for the processing of various types of steel. However, for installations rolling stainless steel it might be desirable to remove particles in the 25 to 10-micron range. In installations of this type, it is usually necessary to go to the replaceable cartridge-type filter to reach this degree of filtration.

The aluminum industry has made many advancements in an effort to clean up their coolant systems for use on highly finished products such as aluminum sheet and foil. A filtration system installed on an aluminum foil rolling operation is shown in Figure 6. The elimination of foreign particles down to as low as ½ micron in size is desired by many aluminum producers.

Another specification that must be met in some aluminum cold rolling operations is the desire to maintain a very low ash content in the oil, sometimes as low as 0.005 per cent. It can readily be seen that a very efficient method of filtration is required in such cases.

In the past it had been the generally accepted practice to use pleated paper or laminated disk-type cartridge filters for full-flow filtration on mineral oil systems, while Fuller's earth cartridge-type filters were operated on the by-pass. The amount of by-pass filtration through the Fuller's earth ranges from 15 to 25 per cent of the total oil being supplied to the mills rolling material such as brass, stainless steel and aluminum sheet or strip; and as high as 25 to 50 per cent of the total flow when rolling aluminum foil. This is due to the fact that the foil rolling operation at high speeds with long contact time produces a higher degree of foreign contamination and oxidation products.

The benefits of the automatic precoat-type filter have been tested by most of the major aluminum producers, and they have installed and are now operating these filters while using both diatomaceous and Fuller's earth as a filter aid. Diatomaceous earth is comprised basically of the siliceous remains of microscopic marine plants known as diatoms. This type of filtration is not new to the filtering industry, having been used in the fields

Figure 8 — The filter aid is discharged into a tote box after the oil has been recovered and the aid has been dried.

of chemical filtering, paper making, petroleum refining, etc. Particles of diatomite are microscopic in size, ranging in some grades down into the collodial size range. When precoated on a filter screen, the particles have a tendency to interlock, forming a very strong filtering cake with microscopic voids. This, coupled with the porosity of the diatomaceous earth itself, makes it one of the finest filtering mediums available.

Being chemically inert, the filter cake removes only foreign particles in the oil and falls in the classification of mechanical filtration (having no chemical reaction on the oil). Most additives used in mineral oils today will not be removed by this type of filtration.

Figure 7 shows a typical installation of an automatic precoat filter in use on a modern foil mill. The oil is processed through the filter on the by-pass, offering no restriction of the oil on the way to the mill. In installations requiring a high degree of filtration (such as foil) it is often necessary to filter as much as 110 per cent of the oil being supplied to the mill. Thus, with the oil divided into two sections, a prefiltered and a filtered section, the oil as it returns from the mill to the reservoir would be drawn from the prefiltered section through the filter, and thence to the filtered section of the reservoir. In this system, the oil is filtered at a greater rate than it is supplied to the mill.

In installations where a high degree of oxidation is produced in the rolling operation, such as in cold rolling aluminum, it is necessary to incorporate Fuller's earth in the automatic precoat filter. During the filtering operation after the filter has been precoated with diatomaceous earth, a constant flow of a combination solution of diatomaceous earth, Fuller's earth and

coolant system oil is fed into the filter at all times. This is called body feed and builds a porous cake on the filter tubes which avoids excess pressure drop through the cake. It also permits the Fuller's earth to adsorb (by molecular attraction) any oxidation products that might otherwise pass through due to the fact that their size would be smaller than the ½-micron filtering capabilities of the diatomaceous earth.

The filter automatically backwashes and recovers all oil from the filter aid. After an automatic drying operation the filter aid is dumped into a tote box for removal, eliminating the costly operation of manually changed cartridges, see Figure 8.

This advanced method of filtration has done much to improve production on high-speed mills rolling foil down to 0.00025 in. Some other advantages of clean coolant free of oxide and carbon contaminants are:

1. Improved sheet and foil quality by reducing staining, increasing brightness and reducing the pinhole count.
2. Increased roll life, due to reducing roll graying caused by oxide in the coolant.
3. Elimination of excess slippage in the rolling of sheet aluminum and stickiness encountered in foil rolling.
4. Reduction of mill operating costs by prolonging the life of the oil.
5. Reduction of system operating costs by eliminating manual filter and reservoir cleaning.

The diatomaceous filtering method is also being tested, both in the laboratory and on full scale operations, for filtering soluble oil and water used in hot rolling aluminum and cold rolling steel.

This article has illustrated the most common methods of coolant system arrangements. The trend in cold rolling operations is toward faster speeds and higher finishes in many cases. This will require improved coolant systems and methods of filtration, the responsibility falling upon the designer of the central coolant system.

Discussion

PRESENTED BY

R. W. KENYON, General Sales Manager, Kerns United Corp., Chicago, Ill.

J. PHILIP WETTACH, Manager, Mill Lubrication, Engineering and Construction Div., Dravo Corp., Pittsburgh, Pa.

S. W. STOUFFER, Director of Construction and Maintenance, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

R. W. Kenyon: The author mentioned a storage temperature of 130 to 150 F. There are now available totally fatted products that may be stored at temperatures much lower than 130 F minimum. Also, these same oils may be used in solution at a temperature much lower than the 130 F mentioned.

In the work with earth filtering systems have there been any determinations made regarding the selective loss of additives used in the rolling oil? If so, is there a great difference in the amount of loss between the various additives commonly used in the aluminum industry?

J. Philip Wettach: The problem of additive removal is something everyone is very interested in. The oil companies have special additives for mineral rolling oils for various products. In many cases the strip producers purchase a base oil and add their own special additives. It is felt that the statement, "Fuller's earth will not remove additives," cannot be made because it is known that it has an adsorption quality and it will have a molecular attraction to any polar compound that might be used as an additive.

In comparing the two types of systems referred to in this article, the by-pass Fuller's earth cartridge filter method should be examined first. The oil is passed through two in. of Fuller's earth at the rate of, say, 35 gpm through a filter filled with 700 lb of Fuller's earth. In this instance, the filter has a tendency to adsorb the contamination and then it begins to remove additives from the oil. Because the oil is moving through a thick layer of Fuller's earth at a slow speed, there is a danger of stripping the oil.

Now, the reason that one can make the statement that a lesser amount of the additives are removed in the diatomaceous and Fuller's earth type of filter is the fact that one does the majority of the filtering with diatomaceous earth which, as was mentioned, is inert. This will remove all contamination down to ½ micron in size without affecting the additive content. The amount of Fuller's earth that goes into the filter is automatically controlled from a control panel where the operator has preselected the amount of body feed required. Therefore, only enough Fuller's earth is put into the filter to remove the oxidation products that would be smaller than ½ micron in size.

S. W. Stouffer: Would the author, on the basis of his experience, give us some idea of the ability to control roll contours by oil coolants in the processing of tin plate? That is where an attempt is being made to control shape, while taking heavy reductions at fairly high speeds with considerable heat transfer.

J. Philip Wettach: In the rolling of sheet and foil in the aluminum industry, spray nozzles are spaced from 1½ to 4 in. apart across the entire width of the rolls. Individual valves mounted on a coolant console are used to regulate oil supply to each nozzle, thereby roll shape is controlled to some extent.

In the steel industry when working with heavier gages, the coolant supply to the rolls does not usually have this close spray pattern control. Often the spray headers are divided into only three control sections.

Dr. Stone discussed the roll crown adjustment of the backup rolls by hydromechanical methods. This appears to permit a more rapid change in roll shape.

As far as is known, the steel industry has not developed roll shape control, by use of coolant, to the extent that the aluminum industry has. ▲

Developments In Drive Systems and Gage Control For Reversing Cold Mills

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Metal Rolling Application Engineering Operation
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. . . . control of the single-stand reversing mill has progressed at a slower rate than that for tandem cold mills, but recent developments and modifications of existing equipment have produced accurate and applicable control systems which permit the rolling of strip to close tolerances at high speeds . . . .

THE reversing cold mill is an important link in the process of producing cold strip. This mill is called upon to roll a wide range of products accurately. With the entry into the space age, the reversing cold mill is called upon to roll more exotic metals to ever greater accuracies. For conventional metals, the reversing cold mill remains the "workhorse" of the industry.

A discussion of stand and reel horsepower selection has been covered in a previous article.[1]* The intent of this article is to complement the earlier article and to discuss recent developments and trends.

To permit rolling a wider range of products at higher strip speeds and to ever more accurate tolerances, mill builders are solving the mechanical problems to push toward new frontiers in rolling cold strip. It is the hope and intent of the electrical industry that the electrical equipment will not only keep pace with and never limit the process, but will also contribute toward the solution of many problems. Mechanical problems are sometimes solved electrically (and vice versa). Therefore, close cooperation between the customer, the mill builder and the electrical supplier is necessary to obtain the optimum performance from a mill.

The electrical industry is continually striving to improve its equipment. D-c control panels have been redesigned for more accessibility, greater safety, easier maintenance and reduced size. As Figure 1 illustrates, these improvements have also resulted in a better appearance.

* Numbers in parentheses refer to Bibliography at end of article.

Regulators using silicon-controlled rectifiers have become firmly established for nonreversing applications. This new device provides better performance, requires less maintenance and is panel mounted for more complete factory wiring and testing. This type of regulator is now being applied to a reversing cold mill. In the future, more reversing cold mills will probably be supplied with silicon-controlled rectifiers.

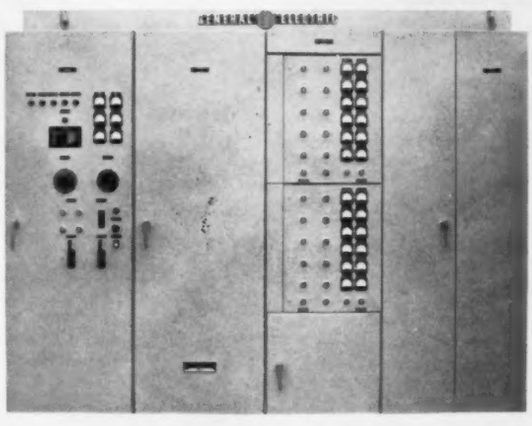
Many of the smaller mills have been supplied with packaged power units where the motor-generator set is enclosed with the controls, see Figure 2. There are separate power units for the mill stand and for each of the reels. Sometimes the power units for the two reels are combined in one cabinet. The packaged power units require less floor space, are more completely factory wired and tested and are more economically installed. These units are now available for medium sized mills.

MILL STAND REGULATOR

The strip connects the mill and reels rigidly together. It is obvious that the control for the mill and reels must be very closely co-ordinated in order to maintain constant tension. For this reason, a regulator on the mill motor is a very desirable feature.

Without a speed (or voltage) regulator on the mill motor, its speed will vary with load. Temperature changes in the motor, generator and controls will also affect the speed. Breakaway from stall will be determined by friction and the amount of reduction. Residual generator voltage will contribute to unpredictable operation at slow speeds. However, there are mills with

Figure 1 — Redesigned control panels have increased accessibility and safety.



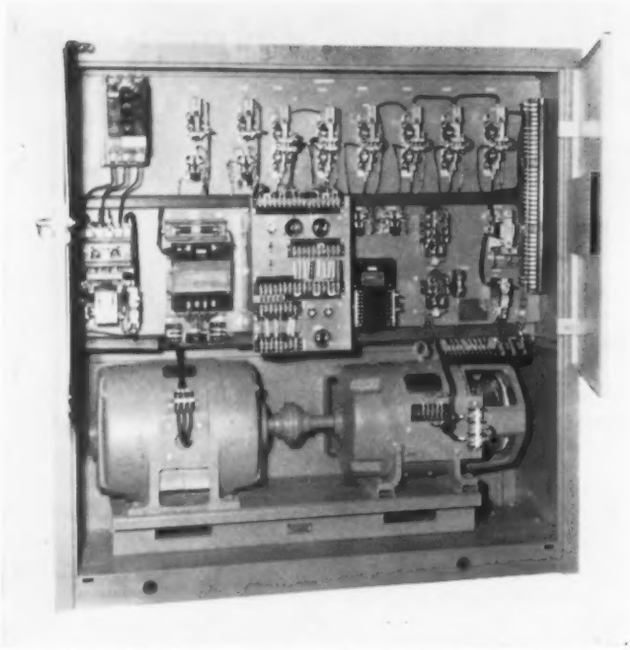


Figure 2 — To conserve space, the motor-generator set is often enclosed in the control cabinet.

products and gages that have been successfully rolled without a regulator on the mill motor.

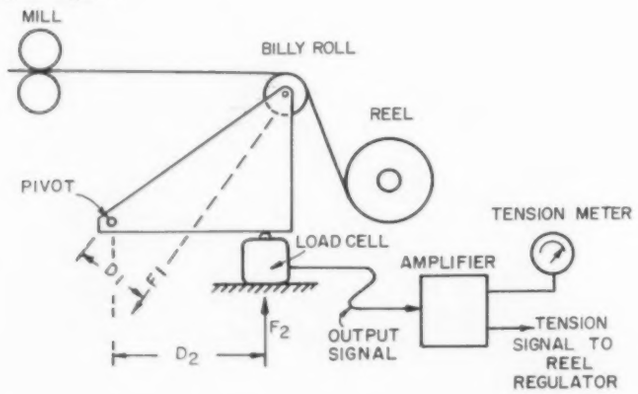
With a regulator on the mill motor, the motor speed will be forced to follow closely the position of the master motor-operated rheostat regardless of changes in load, temperature or generator residual voltage. The regulator controls the mill speed precisely; therefore, greater coordination is possible between the mill and reels.

On acceleration and deceleration, inertia compensation is applied to the reels in order to accelerate their inertia. If this compensation is not applied at the moment the strip speed changes, there will be a change in strip tension. If the mill speed is accurately controlled, the inertia compensation can be more accurately timed to reduce the tension deviations during a change in strip speed. This is the chief advantage of the mill regulator and improves the performance of the mill by extending the tension range or permitting faster acceleration of the strip.

TENSIOMETERS

One way to obtain a signal of strip tension is to use a pressure sensing device (load cell) under the idler or billy roll on each side of the mill. A typical arrangement is shown in Figure 3. The tension in the strip causes a torque F_1D_1 about the pivot point. This torque is opposed by torque F_2D_2. Therefore the force on the load cell is proportional to the strip tension. The pivot point is located so that coil build-up has minimum effect on the accuracy of the tensiometer. As the coil builds up the force F_1 will increase, but the moment arm will decrease. The result is that F_1D_1 is the same at empty coil as at full coil if the pivot point is properly located. Normally the error at midcoil can be neglected. However, calculations should be made to determine this error. One way to eliminate an excessive midcoil error is to add an idler roll to maintain the pass line over the tensiometer mechanism. The output of the load cell is amplified for indicating and regulating purposes.

Figure 3 — Strip tension is a function of the load cell output signal.



The load cell consists of an accurately machined steel column with wire-wound strain gages bonded to the four sides of the column, see Figure 4.

These strain gages are connected in the form of a balanced Wheatstone bridge. With zero load on the steel column, the bridge is balanced and there is zero output. When load is applied to the column, the column will be compressed slightly (less than 0.01 in.). This compression changes the cross-sectional area (and thus the resistance) of the wire in the strain gage by a small amount. This change in resistance unbalances the bridge and produces a voltage output that is proportional to the force on the load cell. The load cell is a rugged device with no moving parts and is hermetically sealed to keep out oil and moisture.

Calibration of the tensiometer is simple, fast and accurate. A resistor is connected across one leg of the Wheatstone bridge. Pressing the calibrate button unbalances the bridge and causes an output voltage to appear. The value of the resistor is selected to give the same voltage output as if a force proportional to full tension were applied to the steel column. In this way, the transistor amplifier and tension meter are electrically calibrated.

TENSIOMETER REGULATORS

With a true strip tension signal available, it is feasible to regulate strip tension directly. Many of the newer mills with wide tension range have tensiometer regulators. A tensiometer regulator will hold tension more accurately than a current regulator. This is especially true at light tension when the gear losses noticeably affect the accuracy of a current regulator. Gear losses do not affect the accuracy of the tensiometer regulator. Tests have shown that the tensiometer regulator is superior at constant strip speed and on changes in strip speed.

However, the current regulator is simpler, less expensive and requires less maintenance than the tensiometer regulator. For this reason mills with a tension range of less than ten to one would normally be supplied with current regulators. On mills with a wider tension range, tensiometer regulators should be considered.

POSITION REGULATOR

On small mills with reels of 60 hp and smaller, a position regulator has been used to control strip tension. The principle of this system is shown in Figure 5. Air pressure is applied to one side of the mechanism

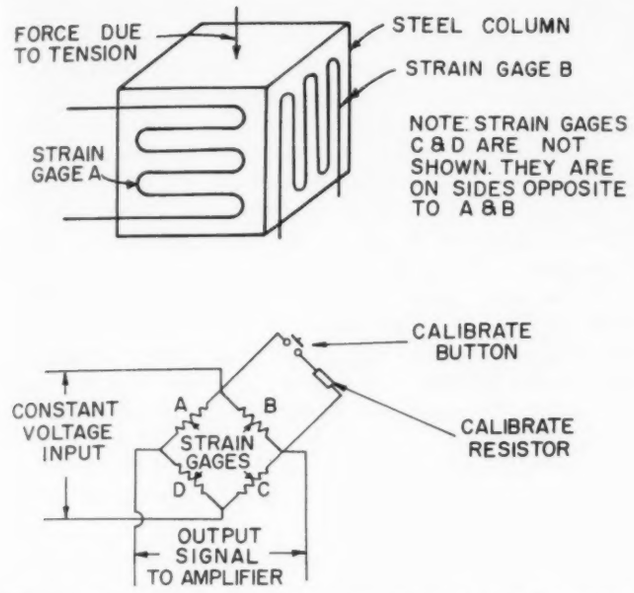


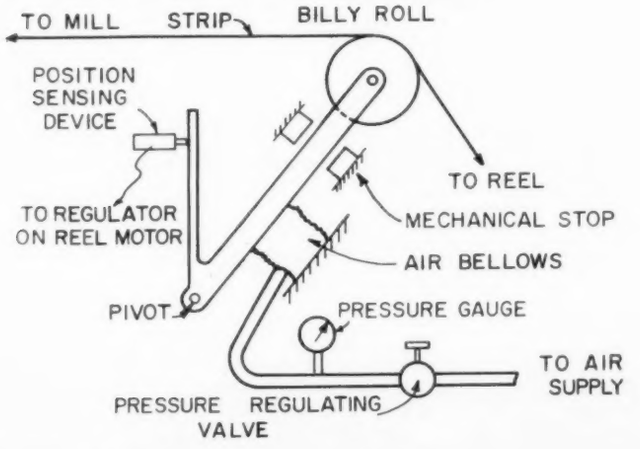
Figure 4 — The load cell is composed of strain gages bonded to a steel block.

which produces a torque about the pivot point. This torque is counteracted by a corresponding torque created by the tension in the strip. A position sensing device supplies a signal to the reel regulator which initiates correction of any motion of the mechanism from the preset center position. As long as the mechanism is between the two mechanical stops, the strip tension is proportional to the air pressure applied. This system has been successfully applied to many small mills with tension ranges of more than 40 to 1. These mills have small reels, with speeds up to 500 fpm and relatively long accelerating times. In the future, larger reels may be supplied with this system of regulating strip tension.

TENSION RANGE

Predicting a permissible tension range would be more of a science if the capabilities of the mill operator could be reduced to a constant and factored into the calculations. A capable operator can make estimates of permissible tension range look very conservative. It is known that many mills are rolling thinner strip than was originally intended or thought practical when they were purchased.

Figure 5 — Mills with tension ranges of 40 to 1 and higher have successfully used the position regulator.



With a current regulator, a tension range of ten to one is feasible with one motor per reel. Usually control is provided that will accelerate the mill to top speed in from 11 to 33 sec. The minimum accelerating time is usually determined by the Wk^2 and speed of the reel drive, and the effectiveness of the inertia compensation. During installation, the service engineer will adjust the controls to satisfactorily accelerate the thinnest strip to top speed in the shortest time practical.

The tension range of the current regulator can be increased by having two duplicate motors on each reel with provisions for declutching one motor. This permits operating with one motor (and reduced Wk^2) for light tension. The actual amount by which the tension range can be extended is dependent on many factors beyond the control of the electrical manufacturer, such as Wk^2 and friction. It seems reasonable to expect a tension range of 15 to 1 could be achieved in this manner, and in some cases even greater ranges have been achieved. Normally the armatures of the two motors are connected electrically in series for automatic load balance when both motors are used.

The tension range can be extended even further by using motors of unequal horsepower with the larger motor declutched for light tension. In some cases it is possible to avoid unequally sized motors by using three motors per reel with provision for declutching two of the motors. In this instance the motors are duplicates and are usually connected in series for automatic load balance. With tension ranges greater than 20 to 1, it would be advisable to specify a range of accelerating times of 20 to 60 sec. Two rates of strip acceleration can be provided to permit acceleration with heavy tension at a faster rate.

With a tensiometer regulator the tension range of a reel is greater than with a current regulator. The reason for this is that on steady-state operation the gear losses do not affect the accuracy of the tensiometer regulator. On acceleration the tensiometer inherently tries to regulate the set tension and inertia compensation is less of a problem. Tests have shown that the tensiometer regulator regulates tension more accurately under steady-state and transient conditions.

On one tensiometer regulated reel, with a maximum strip speed of 1080 fpm, a 400-hp reel motor and a 30-sec accelerating time, an 18 to 1 tension range has been obtained. This tension range could be increased by slowing the time of accelerating the mill to top speed.

On another reel, with a maximum strip speed of 200 fpm, a 40-hp reel motor and a 30-sec accelerating time, a 66 to 1 tension range was realized.

OPTIMUM REEL DRIVE

Determining the best reel drive for a particular mill is both interesting and challenging. One logical approach is to calculate the tension error due to acceleration with various motor combinations, motor speeds and corresponding gear ratios. The drive with the smallest tension error is the best selection.

The tension error, in lb due to acceleration, can be calculated by using the following formula:

$$\frac{\text{accelerating torque} \times \text{gear ratio}}{\text{reel radius}} = \frac{Wk^2 \times N \times G}{12.8t \times D}$$

where:

N = Motor rpm.
G = Gear ratio between motor and reel.
t = Time in sec to accelerate to top strip speed.
D = Reel diameter in in.
Wk^2 = Total Wk^2 of reel drive in lb-ft^2, referred to motor speed.

This provides a means of comparing alternate reel possibilities. It is recognized that the calculated tension error must be reduced or eliminated by the inertia compensation circuit. Therefore, any reduction of the basic error by selecting the optimum reel drive should improve the over-all accuracy of the system.

Since the greatest tension error is in accelerating either a full coil or an empty mandrel, calculations should be made for both of these conditions. The procedure is:

1. Assume a base speed for the reel motor.
2. Determine the required gear ratio.
3. Determine the total Wk^2 of the reel drive (referred to motor speed).
4. Calculate motor rpm for top strip speed with both empty mandrel and full coil.
5. Calculate the tension error for both conditions.
6. Repeat for other base speeds, suggest 200, 250, 300, 350 and 400 rpm.
7. Repeat for various motor combinations on clutched drives, using the connected Wk^2 only.

Usually the lower base speed (and more expensive) motor will cause less tension error. However, it could easily be that for a particular reel a 300-rpm base speed motor would be much better than a 400-rpm motor, while a 250-rpm motor might be only slightly better than the 300-rpm motor. In this instance, the additional cost of the lower speed motor would not be justified and the 300-rpm motor would be the logical selection. Although this motor is more expensive than the 400-rpm motor, there may be a saving in the gear reducer to offset the additional cost.

AUTOMATIC GAGE CONTROL

Literally dozens of automatic gage controls have been supplied for reversing cold mills. Virtually all of these, until rather recently, have been relatively simple screwdown controls of the sampling variety, often operating from contacting-type thickness gages.

While such controls are perfectly satisfactory for many mills, others could benefit from an improved system. This is particularly true for the higher speed mills, those rolling thin strip and those rolling special, high-cost alloys. For such applications a number of new systems have been developed and these are discussed in more detail.

X-RAY GAGE CONTROL

While a mechanical contacting gage could be used, most applications that call for more sophisticated gage control systems should also have X-ray gages. This is particularly true for mills operating above 2000 fpm.

As is well known, thickness on any mill can be controlled, with certain limitations, either through screwdowns or back tension or, of course, both together. To determine the optimum combination, it is necessary to consider the limitations.

In the case of tension, the first limitation is the size of the reel motors. On the early passes with heavy strip, the reel drive ordinarily will not have enough torque to significantly change the thickness, nor will the coil be able to stand the tension required. For these reasons, and particularly because the inherent thickness variations are greatest on the early passes, it is necessary to use screwdowns at first.

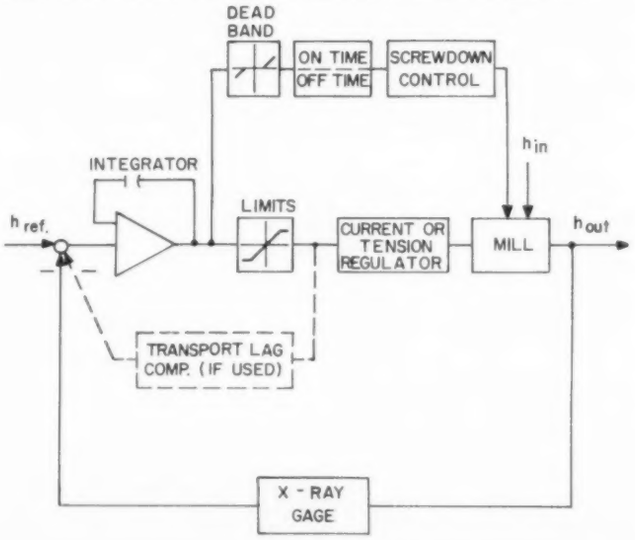
As the strip becomes thinner and harder, the screwdowns tend to have less effect on thickness due to roll flattening. This means that, if the screws alone are used, larger screw movements become necessary to produce a given per unit correction. This has the effect of slowing down the control. This is particularly undesirable because with thinner strip the rolling speed is likely to be higher. Excessive screw movements may also affect strip shape adversely.

Back tension, on the other hand, tends to have an increasing effect on thickness as the strip becomes thinner. Since the total tension available remains the same, the possible range of control by this means increases as strip thickness decreases. Thus, control by back tension becomes relatively easier as control by screwdowns gets more difficult. This coupled with the fact that on the later passes many if not most of the gage variations are caused by changes in tension, makes it the logical choice for thin strip.

IDEAL CONTROL

Thus, the ideal control is one that combines screwdown and back tension changes. This is accomplished by controlling primarily through back tension, with the screwdowns used to keep the tension in range. This has the advantage that the back tension control can easily be a continuous control since the reel current (tension) regulator is very fast, and it does not put any strict performance requirements on the screwdowns. In fact, a conventional sampling control is used, and the screwdowns can have either constant potential magnetic control or variable-voltage drive, although the latter is, of course, always preferred. Figure 6 shows a simplified block diagram of this system.

Figure 6 — A gage control system using both back tension and screw-down changes is shown in block diagram.



Limits are built in to prevent the tension from changing more than a predetermined amount, nominally about 20 per cent. Just before the tension limit is reached the sampling control causes the screwdowns to run. The ON time is selected to approximately correct the deviation that caused the tension change, so that tension will return to the initial value. Since an integrator is used in the back tension control there is no steady-state error even before the screwdowns run.

On heavy strip the tension limits are reached very quickly, causing the screw-down control to take over, and the system operates essentially as a screw-down type control. At the other extreme, with light gage strip, the corrections are made almost entirely by tension, and the screwdowns operate seldom if at all.

AUXILIARY FUNCTIONS

Experience has shown that when an operator becomes accustomed to an automatic control he tends to rely on it quite completely and perhaps uncritically. If adjustments for important parameters are provided they present an opportunity for improper setting as well as inconsistencies between different operators. For these reasons it is important that the control itself have the capacity to handle different situations without the need for adjustment by the operator. This function is provided by open loop programming.

At low mill speeds the transport time from mill to X-ray gage is long, and the control must be much slower than it can be at high speed. Automatically adjusting the response continuously as a function of speed insures that one has the optimum conditions at all speeds.

With different widths and strip thicknesses the rolling tension will vary over a wide range. It is obvious that the permissible tension variation with wide, heavy strip might easily exceed the total tension used on light gage. Since the operator must select the proper tension for each pass, the logical solution is to program the limits from the tension setting rheostat.

In order to keep screw-down operations to a minimum it is desirable that they operate only when the tension control is approaching a limit. Thus, the sampling control dead-band must be co-ordinated with the tension limits. To accomplish this, it is programmed from the tension rheostat, also.

Finally, the amount of screw-down movement required to restore the tension to the nominal value will change with strip thickness. To compensate for this, the sampling control ON time is programmed with GAGE SET.

Figure 7 — The gagemeter system uses the roll gap as a measuring device and as a control.

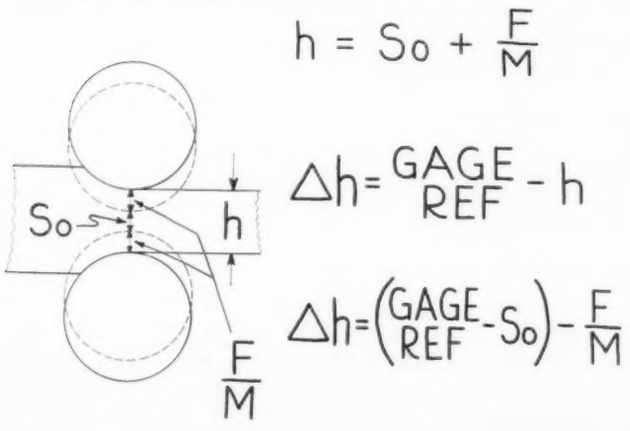


Figure 8 — Tin plate is rolled on a 4-high mill using gagemeter control.

TRANSPORT TIME

One of the limitations in the performance of a gage control such as the one described is the transport time between the roll bite and the gage. This causes a phase shift which tends to make the control less stable. The usual means of compensating for this is to slow down the control.

In order to permit faster performance, three methods of overcoming this phase shift have been developed and are being evaluated. The three methods are called transport lag compensation, the gagemeter and the elongation control system.

Transport lag compensation—Transport lag compensation, as the name implies, is a means of compensating for the phase shift caused by transport time.[2] As indicated in the block diagram (Figure 6) this is in the form of a feedback of the regulator output. When the regulator output changes, the normal feedback is through the change in strip thickness registered by the X-ray gage. However, this feedback is delayed by the transport time, and this is the cause of the trouble. The transport lag compensation (TLC) provides a feedback during the transport time and, in effect, fools the regulator, since it cannot distinguish between the real and the lag compensation feedbacks. This enables the speed of response of the gage control to be made as high, or even higher, than it would be if there were no transport time.

Needless to say, the transport time is not actually eliminated. No correction can start until the error reaches the X-ray gage. Transport lag compensation simply allows the correction to be made more quickly once it starts.

Gagemeter system—To really eliminate transport time requires that thickness be measured while the strip is in the roll-bite. This is accomplished by the gagemeter. Since this has been adequately described in papers presented before the AISE and elsewhere,[3, 4] it will not be described in detail. The gagemeter computes roll separation (output thickness) by adding unloaded roll opening (S_0) and mill spring (F/M). This principle is illustrated in Figure 7.

The gagemeter has been applied to several 4-high

reversing cold mills, one of which is shown in Figure 8. Its greatest limitation has been caused by backup roll eccentricity, which produces a false deviation signal that causes the control to make a correction in the wrong direction. Thus the control must be made insensitive to this signal.

For these applications the eccentricity signal is best attenuated by a filter. However, this has the disadvantage of slowing down the system. In fact, with an ordinary filter and quite reasonable and common amounts of eccentricity, the over-all response will be poorer than when using an X-ray gage with the attending transport time.

It has been found, however, that when a properly designed, tuned filter is used, it is capable of greatly attenuating eccentricity signals with practically no sacrifice in response. In fact, based on work done so far, it appears that this single innovation will probably make the difference between the gagemeter system being significantly faster than an X-ray system and not.

In spite of the success of the tuned filter there have been disappointments with the gagemeter. One of these concerns the problem of rolling on gage to the end of the coil. It was hoped that the faster response attainable by eliminating transport lag would make it possible to correct the heavy gage at the ends of the coil. However, it turns out that because of roll force considerations, the gage control must be turned off at a relatively high speed, so this goal has not been achieved.

Another disappointment was in the discovery that the gagemeter is not an absolute measuring means. That is, it requires a radiation or contacting gage as a monitor to correct drift and other errors.

The question, then, is what is the place of the gagemeter in reversing cold mill gage control. Although it has not yet been fully evaluated with the new tuned filter, certain facts seem to stand out.

Where X-ray gages cannot be used or are undesirable for some reason, and contact gages must be used, the gagemeter seems to have a place. It provides a better signal for the gage control than the contact gage at higher strip speeds.

In fact, where contact gages can be used as monitors, so that radiation gages may be dispensed with, the resulting saving will go a long way toward offsetting

Figure 9 — The elongation control requires strip contact at the entry and exit sides of the mill.

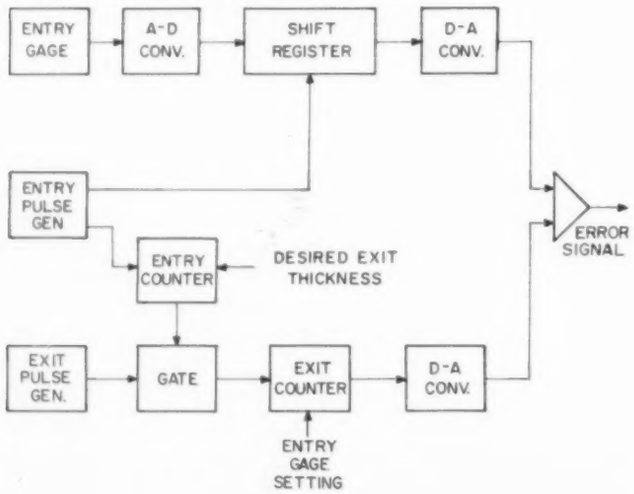


Figure 10 — A 50-in. sendzimir mill is equipped with the elongation control system.

the cost of the gagemeter. This is because one gagemeter does the job of two radiation gages.

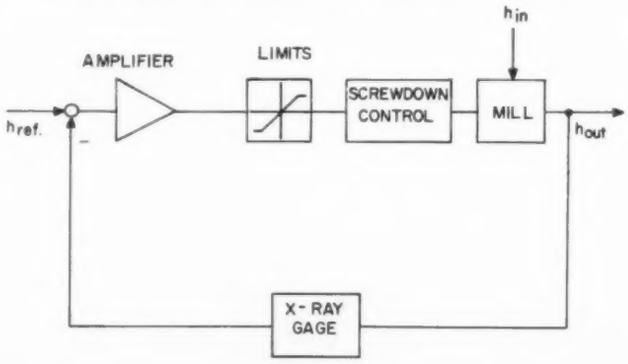
There is also some indication that on high-speed single-stand mills for rolling very light gages such as tin plate, the faster control possible with the gagemeter may justify its higher cost and complexity.

Elongation control—The basic principle of this system[5] is that the outgoing gage is equal to ingoing gage divided by the elongation. The ingoing gage is measured several ft ahead of the mill, but the measurement is stored in a shift register until the strip reaches the roll-bite. At this instant elongation is determined from pulse tachometers on each side of the mill and the computation of thickness error is made digitally. A simplified block diagram of the computer is shown in Figure 9.

This produces a thickness measurement not subject to transport time delay with the advantage (over the gagemeter) that roll eccentricity does not produce false signals. Its disadvantages are the dependence on strip-driven rollers for the elongation measurement and the complexity and resultant high cost of the digital computation circuitry required.

The place for elongation control seems to be where extremely high control accuracy is required, and it is permissible to operate the mill at a slow speed to achieve it. At high speeds the inherent time-delays in the control and the mill become relatively so long compared to the transport time that eliminating it produces very little gain. One sendzimir mill has been equipped with this system (Figure 10) and another system is being built for a 4-high mill. Both applications utilize screw-downs only for control.

Figure 11 — Automatic gage control applications on sendzimir mills often use continuous screw-down control.



SENDZIMIR MILLS

The sendzimir mills are unique in several ways that influence the choice of gage control. They use very small and very hard work rolls. This results in a rather short arc of contact with the strip, which in turn restricts the permissible range of tension variation. On the other hand, such work rolls, by exhibiting less flattening, are more effective in controlling thickness through roll pressure down to very light gages. Fortunately these mills utilize a hydraulically-operated screw-down mechanism which is very easily and precisely controlled.

In consideration of all of these factors the logical gage control system is a continuous screw-down control, see Figure 11. In this system the X-ray deviation signal is amplified and used to control a hydraulic servo-valve in parallel with the solenoid valves used for manual screw-down operation. With such an arrangement screw-down speed is proportional to deviation. There is no dead-band and, in steady-state, no error.

SUMMARY

Although the trend today is more and more toward tandem mills for high-production cold rolling, reversing and nonreversing single-stand mills will continue to be important to fabricators and smaller producers and for special orders or products even in the largest plants. For this reason they have not been nor will they be forgotten by the electrical industry, and continued progress should be expected in the future.

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Discussion

PRESENTED BY

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ALONZO F. KENYON, Advisory Engineer, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

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R. M. SILLS, Metal Rolling Application Engineering Operation, General Electric Co., Schenectady, N. Y.

A. Bisci: The authors' comments are of particular interest since Dofasco pioneered the roll gap measurement method of gage control on this continent in 1959. Since then it has been installed at Dofasco on five reversing cold mills for the production of tin plate. As the authors have pointed out, until recently the most objectionable part of this method of gage control was the backup roll eccentricity ripple. The development of the tuned filter has almost eliminated this problem and it is felt that the extra cost involved in this system is certainly justified.

Alonzo F. Kenyon: The authors are concerned primarily with gage control. However, they emphasize, as has been done previously (Automatic Gage Controls on Reversing Cold Strip Mills—Aug., 1961, *Iron and Steel Engineer*, p. 77) that it is necessary first to have good control systems for both the mill drive and the reel drives. Among the important and essential features of the mill drive control is a voltage regulator or speed regulator to assure uniform and stable threading speed, and to assure that the mill speed closely follows the master rheostat position during acceleration and deceleration.

Mention was made of the use of tensiometers and similar position regulators to obtain accurate reel tension control and thus permit larger ranges of tension adjustment than are considered practicable with the more familiar and simpler current regulator type of reel tension control. Tensiometer regulator control may be justified in some special circumstances. However, the first and major emphasis should be given to the selection of the motor drive itself to get the minimum practicable Wk^2, and other desirable machine characteristics.

Also, development has gone forward on systems for more accurate current regulator tension controls utilizing transistorized computing amplifiers to generate an inertia compensation signal which truly reflects the correction which must be made in order to maintain the selected tension during acceleration and deceleration. These advanced systems are essential on mills rolling extremely large coils with resulting large variation in reel coil inertia and large range of coil build-up, and on mills requiring a large range of tension adjustment.

Eugene R. Johnson: The authors discussed the tensiometer and its use with the ideal tension regulating system. In Figure 3 it was noted that a pivot point was used on the tension measuring roll assembly and the authors commented that there was an error because of coil build-up as metal is being wrapped on the reels.

There is also an error because of measuring roll motion around the pivot point. A tensiometer which does not require a pivot point has recently been developed and measuring roll deflection is reduced to less than 0.002 in. Since the measuring roll motion is so small, a nearly constant force triangle can be formed thus providing a tensiometer with improved mechanical accuracy. This new tensiometer has been applied for reel tension indication and regulation on the new sendzimir mill being installed at Granite City Steel Co.

R. M. Sills: It should be made clear that both of the tensiometers described require very small billy roll movement. The error mentioned due to coil build-up is not caused by the movement required of the tensiometer, but simply by the geometry of the mill. If an additional billy roll were to be provided the tension triangle would remain constant, and errors due to build-up would be eliminated. It is also possible to eliminate this error through the use of an extra dial on the memory rheostat. ▲

Recent Developments in Rolling Mill Equipment

by W. L. STOVER, Assistant Chief Engineer, Mesta Machine Co., West Homestead, Pa.

Continuing effort in the steel industry has led to the development of many important production advances, which have increased equipment ulilization and reduced over-all costs.

THERE are three recent developments in rolling mill equipment which will be discussed in some detail: (1) an automatically-sequenced mash welder for tin-plate gages; (2) a motorized wedge adjustment of knife clearance for plate shearing and (3) movable housings for a mill using two different lengths of roll bodies.

MASH WELDER

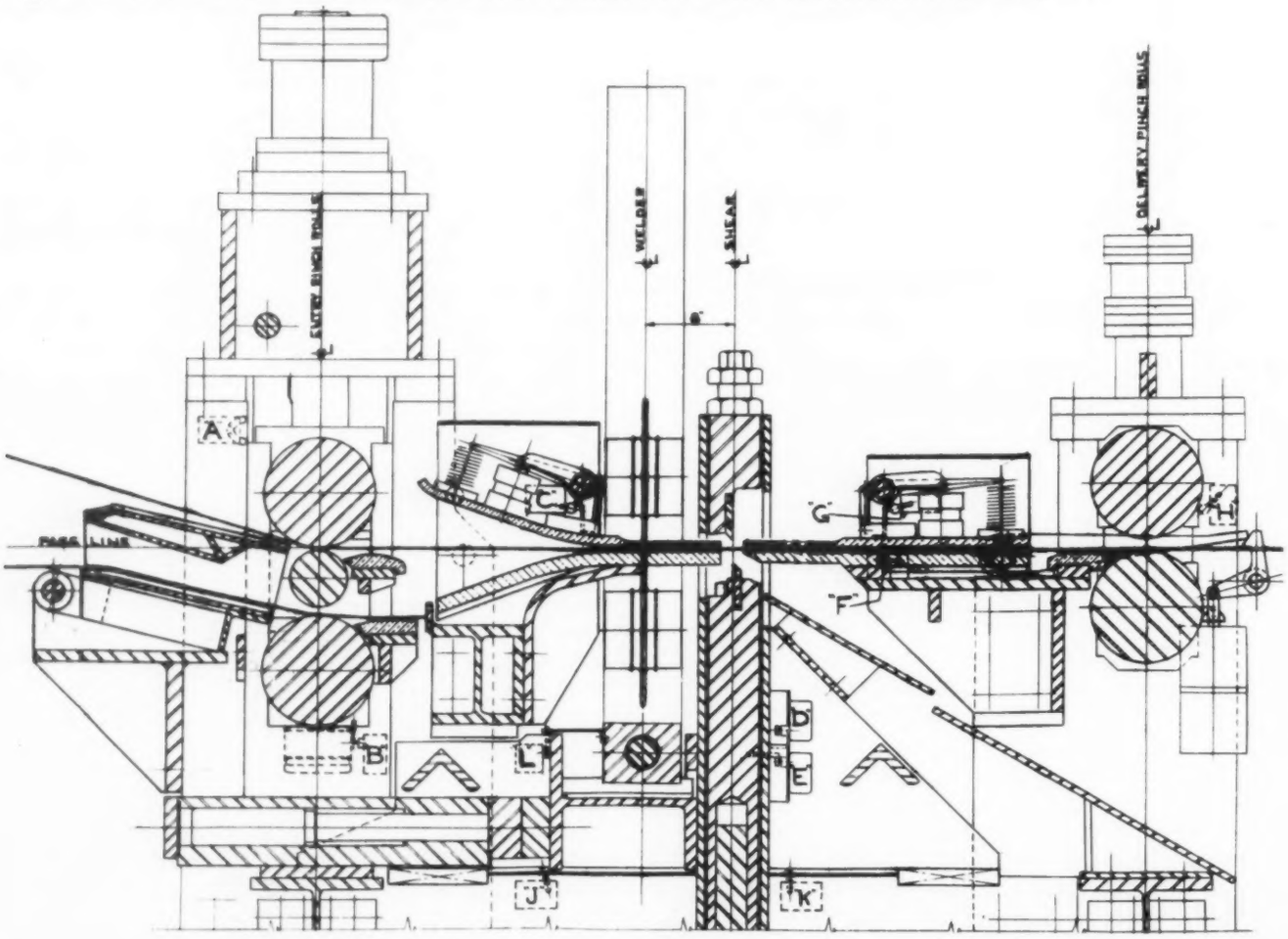
Mash welders for both sheet and tin-plate gages have been in operation for some years. These were semi-automatic, but required a man to push a button for each separate step in the operation. This was satisfactory on slow-speed galvanizing lines, but caused a longer welding time cycle than was desired on high-speed annealing lines. In order to decrease this welding time cycle a fully automatic welder was developed.

Figure 1 shows the arrangement of the welder unit used for tin-plate gages only. The unit consists of 3-high entry pinch rolls, entry and delivery welder clamps, shear, welder and 2-high delivery pinch rolls. The entire unit is mounted on a common base.

As is common on an annealing line, two pay-off reels are used. The position of the various elements shown is for the strip to be running through the welder unit from the No. 1 pay-off reel, which feeds the strip over No. 2 reel on a high pass line. The head end from the coil on No. 2 reel, which has been previously prepared to remove off-gage material, is in position for the weld cycle. When the coil on No. 1 reel has been payed off, with exception of the off-gage material, the entry end of the line is stopped. Stopping the line automatically starts the weld cycle and the unit goes through the following steps:

1. The delivery pinch rolls clamp the strip.

Figure 1 — Sectional view of the automated welder indicates the relative compactness of the unit.



2. The strip is sheared, the delivery side is clamped, and the clamp is locked in an elevated position.

3. The entry pinch rolls shift up and clamp the strip.

4. The entry pinch rolls rotate a fixed amount to place the new head end in the shear and move the old strip out of the way. It is recoiled on No. 1 reel.

5. The entry clamps close and the new strip end is sheared. The scrap falls down a chute into buckets.

6. The delivery clamp is unlocked to lower the strip to the welding position.

7. The shear and welder are shifted sideways to position the welder in front of the lapped ends of strip.

8. The welder wheels roll over the strip ends making a weld (welding current is turned on automatically).

9. Both pinch rolls and both clamps open and the line starts automatically.

10. The welder and shear shift back eight in. to the starting position.

11. The prepared end of the coil from No. 1 reel is fed into position.

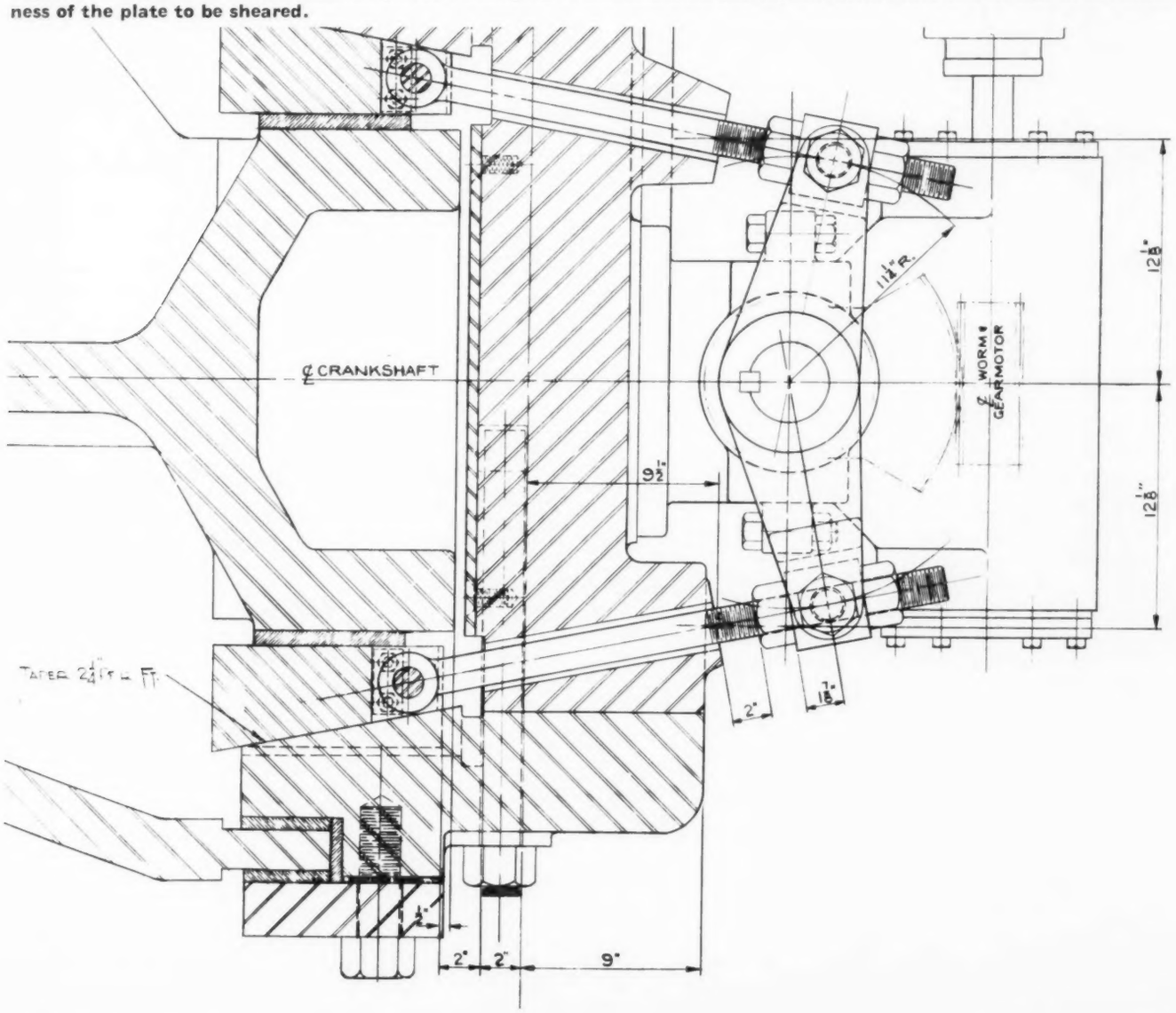
The welding cycle, from stopping of the line to the starting of the line, is approximately 12 to 15 sec. Under purely manual operation this welding cycle requires approximately 45 sec, so that the automatic operation has reduced the welding cycle time to one third of the original time. The 30-sec saving which appears to be insignificant is, however, quite important. For a given line speed during welding, the storage loops may be reduced to approximately one third of the size otherwise required. Or with a given size looping tower the line speed may be approximately three times as fast during the weld cycle.

It should be noted that the shearing position is above the pass line, and it is this fact that provides the slight overlap of the strip ends. The shearing position is adjustable vertically to change the amount of overlap if desired. The overlap used is approximately $\frac{1}{16}$ in., but is adjustable from 0.040 to $\frac{1}{4}$ in. In general the less overlap the flatter the weld.

Four variables exist for the actual welding: wheel pressure, wheel speed, welder voltage and heat. However, for the normal gages encountered on the annealing lines, only changes in the heat adjustment of the welder is necessary.

All of the motions of the welder unit, except one, are positively controlled by mechanical stops. The rotation

Figure 2 — Adjustable knife clearance permits changing of the clearance quickly whenever there is a change in the thickness of the plate to be sheared.



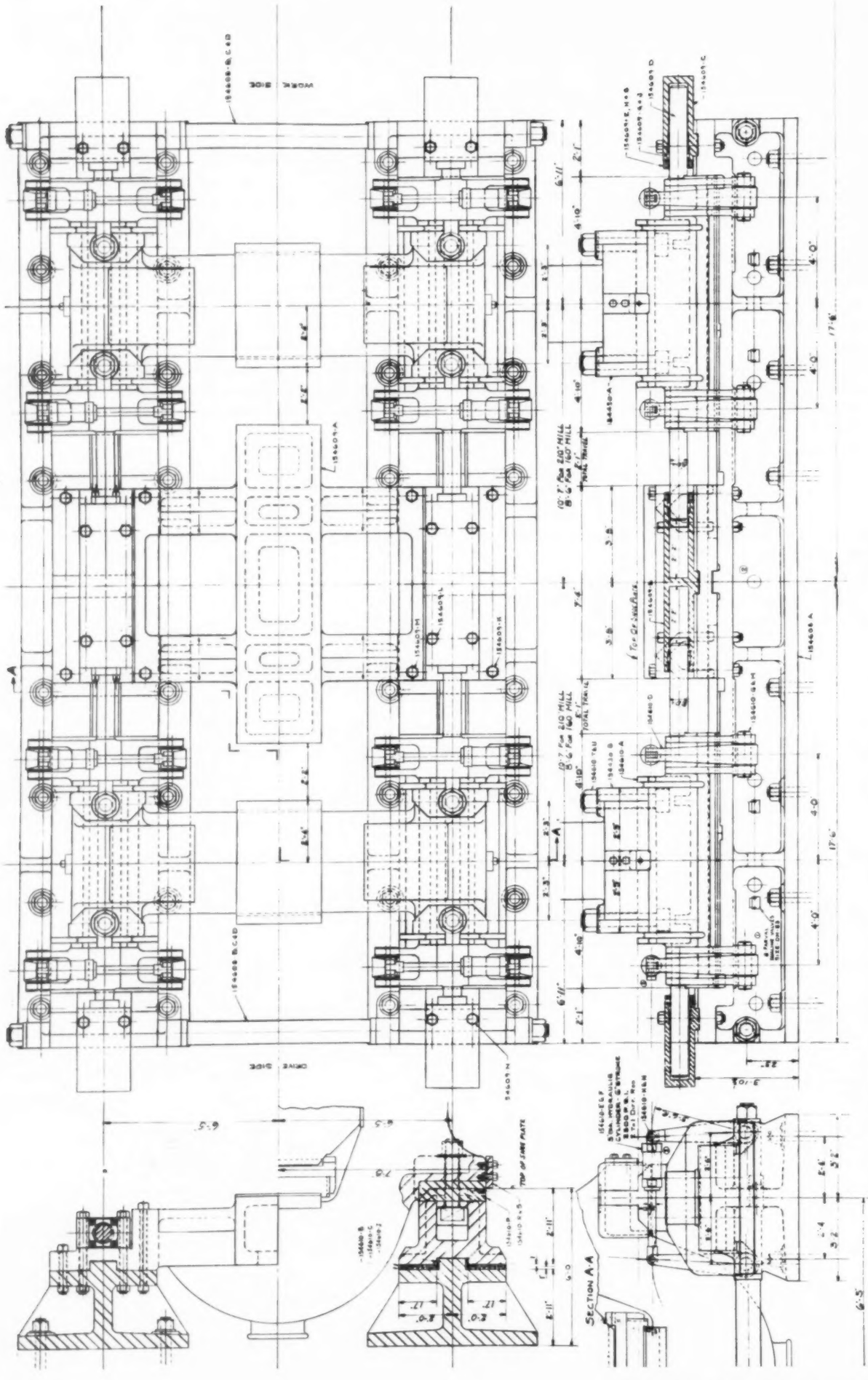


Figure 3 — Extreme care was taken to be certain that no movement of the housings occur during rolling.

of the entry pinch rolls feeds the incoming strip to the shear and is controlled by a cam limit switch, but this rotation is not critical since the strip is not moved after it is sheared. Micro switches are used to indicate that one motion is completed, before the next motion starts, instead of depending upon timers which may be effected by varying friction.

The reliability of the automatic operation is then mainly electrical and emphasis must be placed on good, reliable and durable electrical equipment necessary for continuous service.

PLATE SHEAR KNIFE ADJUSTMENT

The conception of adjustable knife clearance is not new. It has been used on rotary shears for some time and has been proved to be very important. It has also been used on some plate shears, but built along entirely different mechanical lines.

Figure 2 is a horizontal cross section, through the guide of one end of the top knife block, of a shear designed to cut 1½-in. thick alloy steel plate 200 in. wide. The knife block is guided in the shear housings by the bronze liners and wedges. The wedges are connected by reach rods to two yokes which are fastened on a common shaft. The shaft contains a gear segment driven by a motorized worm. By this mechanism the operator may move one wedge in, and one wedge out simultaneously, thereby shifting the top knife block with respect to the bottom knife block, and change the horizontal clearance between the knives.

There are several reasons for the adjustable knife clearance. Tests have shown that proper clearance will reduce shearing load, which in turn should reduce chipping of knives and give longer knife life. Lower shearing forces also will increase the life of all mechanical parts and reduce maintenance of these parts. Most important is the quality of the sheared edge which should be better with proper knife clearance.

As far as is known, very little test work has been done on the proper clearance for plate shears, except that a rule of thumb has been established that the horizontal clearance should be one tenth the plate thickness. This would mean a clearance of 0.150 in. for 1½-in. plate, and 0.025 in. for ¼-in. plate. It is known that the 0.025 in. is about correct for the ¼-in. plate but it is felt that more work must be done on the thicker plates to establish the correct clearance. It is hoped that more data will be available soon. Experience with rotary side trimming shears indicates that the one tenth factor may be a little large and that a factor of one twelfth of the plate thickness may be more in order.

This factor may also be influenced by the condition of the knives, whether sharp or worn, and whether the material is carbon or alloy steel.

MOVABLE MILL HOUSINGS

Figure 3 shows the arrangement of the bottom of the mill with its shoe plates and subbases.

Each housing is supported by two shoe plates, which are guided and supported on subbases grouted on the foundation. The housings are moved in and out about the centerline of the tables. Eight single-acting cylinders, fastened to the subbases serve to move the housings. To move the housings apart the four inner cylinders are pressurized with the outside cylinders exhausted. To move the housings in, the outside cylinders are pressurized with the inner cylinders exhausted. The stopping position of the housings is controlled by fixed stops on the subbases. It is planned to move both housings at the same time. The valves are arranged, with a neutral position, so that the shifting motion can be stopped at any point in the travel. At the completion of the stroke, the cylinder which did the shifting will remain under pressure to help keep the housings in position. In addition, four hydraulically-operated clamps on each moving shoe plate (giving a total of eight clamps per housing) will clamp the shoes to the subbase. Since the sliding ways of the shoe plates will be flooded with the cooling and descaling water, heavy telescoping covers are placed over the clamps and shoe plates to keep the dirt and scale from reaching the sliding surfaces.

The top of the mill is locked together by a hardened steel tapered pin, which fits in one of two positions in the top separators, which correspond to the in or out positions of the housings. The pin is also hydraulically operated.

It is important that there be no movement of the housings during the rolling operation. There is, however, no normal rolling forces that would tend to move the housings. Any effect of crossed rolls is self-contained within one housing, as all rolls are clamped to the work-floor-side housing. There is always vibration, which could tend to move the housings, and broken rolls can exert forces in all directions. For these reasons every precaution has been taken to lock the housings in place.

To prepare the mill for shifting the following operations must be performed:

1. Remove the work and backup rolls.
2. Remove the entry and delivery feed rollers.
3. Raise the entry and delivery deflector plates clear of the housings.
4. Raise the top locking pin.
5. Grease the slides for the shoe plates front pressurized system.

Each of these steps accomplishes more than is implied. The mill is designed so that removing the rolls also removes the top and bottom guides and strippers, and the top roll cooling piping. The feed roller assembly contains the roll cooling piping for the bottom rolls. The new units to go back into the mill will be assembled with the proper lengths of guides and strippers and roll cooling headers to suit the new mill width.

All of the descaling piping, descaling shields and X-ray gage mountings are kept free of the housings so that these need not be changed. However, the descaling headers are sectionalized so that the outside spray nozzles can be turned off when the mill is set for the narrow width.

To avoid changing the spindles when the mill width is changed, the work rolls with the shorter body will have a long neck extension so that the center of the spindle joint will be the same for both width arrangements.

The purpose of the double-width mill is to permit the rolling of wide material when the occasion demands, and to allow the use of shorter rolls most of the time to save roll cost. This arrangement also provides the stiffest mill possible for the majority of the product. ▲

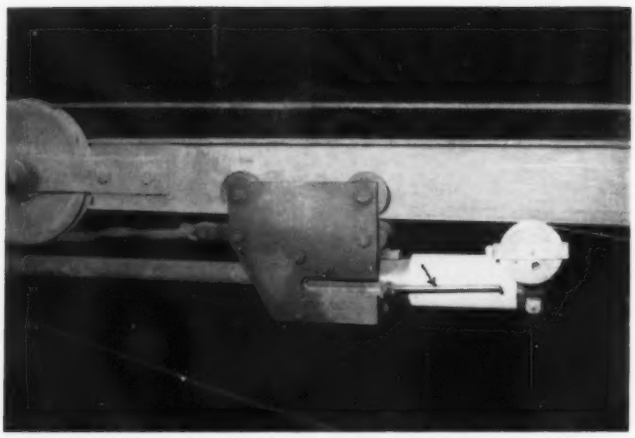


Figure 1 — The force required is noted on the band of the penetrometer by the deflection of the rod, indicated by the arrow.

SPRING-LOADED ROD CHECKS BLAST FURNACE VOIDS

by W. Z. ZOLKOWSKI
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. . . . knowledge of conditions within the tuyère zone of the furnace can be important in determining operational characteristics . . . . a method has been proposed which permits furnace rodding without reducing wind . . . .

BLAST furnace men attach considerable signification to the state of the tuyère zone of the well and particularly to the shape and radial length of voids. Though many investigations were made in the hope of explaining this problem, there is a lack of data concerning the density of the burden, and its ability to create on occasion a "deadman" in the axis zone of the furnace, which leads to a considerable shortening of the voids.

Although the definition deadman was introduced by the blast furnace people, they have not been able to agree whether the term means a quite compact pillar, resisting rod penetration, or whether this pillar may be penetrated by rodding if considerable effort is applied.

Usually it is felt that when the rod, pushed by two to four workmen, is stopped, the deadman is reached.

It is often forgotten that strong and healthy men may push the rod farther than weak or tired workmen. In this way hand rodding sometimes may give quite false results. Therefore, a new method should be applied to present a more accurate solution.

This point of view is likewise represented by two investigators, J. B. Wagstaff and W. H. Holman, whose opinion appeared on page 376 of the March, 1957, *Journal of Metals:* "As yet it cannot be taken as proved, that there is any relation between the variance of the penetration readings and the roughness of the furnace, but this report at least raises the question. Unfor-

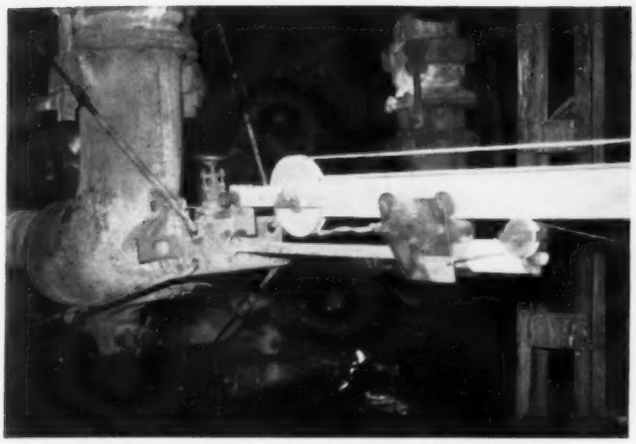

Figure 2 — The rod is accurately alined by the beam on which the carriage rides.

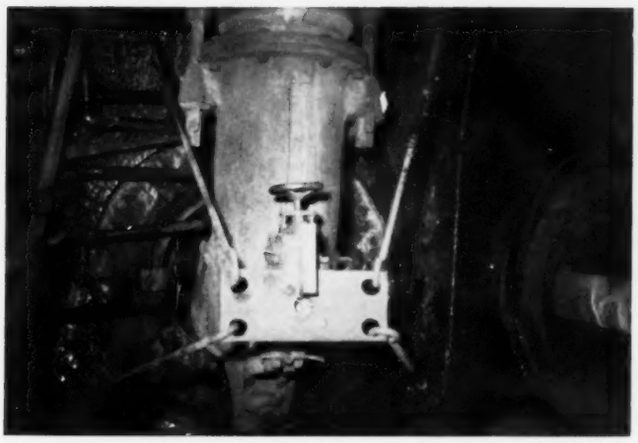

Figure 4 — Rodding of the furnace is accomplished at full blast.

tunately, the physical difficulty of taking these penetration readings probably rules out any thought of using them as a control measurement unless some mechanical means is found to take them. If some such means could be tried, it might well give useful advance information on furnace irregularities."

This report seems quite competent and has encouraged further research in an attempt to find a solution of the problem. A solution seems to have been found which obtains accurate readings without the application of human efforts.

This solution permits the making of exact diagram readings, obtained by mechanical rodding, of:

1. The length of the voids.
2. The density of the burden at total radial extent of the well toward the furnace axis.

The possibility of measuring the burden density seems to be very important, because it can determine the activity in the well zone and discover a real deadman.

An arrangement called a "mechanical penetrometer" was constructed, consisting of a 1.38-in. diameter rod pushed by a motor through the tuyère, as by hand rodding.

The pushing of the rod is executed by the help of a spring, the most important part of arrangement, whose bending is affected by the resistance of the burden and may be read on the band, see Figure 1.

The rod is pulled by a cable along a beam, as it is shown in Figures 1 and 2.

Figure 3 shows some band readings obtained at Bobrek works, Poland, by experimental rodding at several different runs of the blast furnace. That way it is possible to conclude, that the limits of voids may be found in a quite definite way and without any uncertainty; these limits correspond with the external points of horizontal lines, showing no burden resistance, except a small constant inner resistance, about 110 psi of the arrangement.

The steep slopes of the curves, after passing of the rod through the voids, show burden resistance, which at first moment in two cases rises from 1145 psi and from 1430 psi to 2285 psi and in the third case rises slowly to 2140 psi.

All curves show that the maximum resistance does not correspond with the furnace axis, but is reached about 59 in. earlier.

It must be mentioned that a small special additional arrangement shown in Figure 4 permits rodding without decreasing blast pressure.

With the help of this mechanical penetrometer several further investigations are planned at Bobrek works. ▲

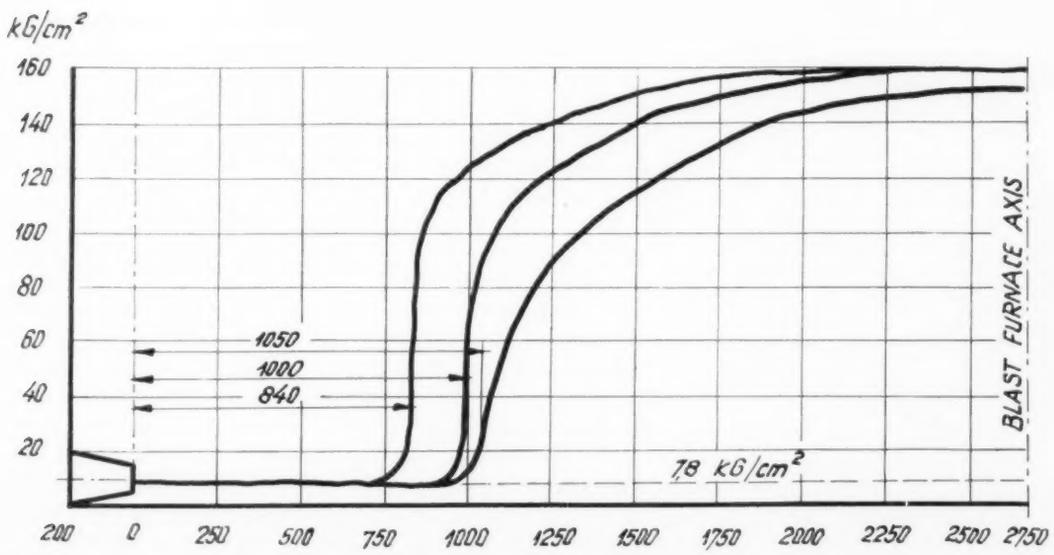

Figure 3 — The resistance to penetration of the furnace burden was measured on several occasions.

D-C DIFFERENTIAL RELAY

by G. L. MARTHINUSS
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. . . . additional motor protection on grounded d-c circuits can reduce motor damage caused by recycling. The differential relay also detects unbalance in motor circuits which might not cause the normal circuit protection devices to operate . . . .

FOR many years, users of d-c electrical equipment on grounded systems were searching for a good ground detecting device. The large number of d-c machines increased the need for an improved protective device that would reduce the extent of the damage when a failure occurs as the result of a ground or unbalanced power circuit current.

The d-c differential relay, as conceived by the Bethlehem Steel Corp., Sparrows Point plant, electrical dept., is to be used on d-c feeder conductors to detect unbalanced current conditions. Proper functioning of standard devices do not protect the machine from extensive damage in many instances. If an overload relay interrupts power, the control can be reset by returning the master switch to the off position. An operator can, therefore, repeatedly re-energize a faulty circuit or a piece of equipment and greatly increase the extent of the damage with each application of power.

For example, on an ore or coal bridge, the 265-hp hoist motors, installed on a trolley frame high above the operator, could be flashed to ground several times before the operator realized that a fault had occurred. A brush-holder, for instance, may operate an overload device when it first flashes to ground. Repeated applications of power can produce sufficient flashing to damage field and armature windings, commutator and starting resistance. If a motor armature coil grounds, laminations could be destroyed in addition to the damage previously mentioned. Frequently, the resulting damage may cost several thousand dollars for repairs and produce lengthy delays.

Such faults, if they are to be minimized, must be removed very quickly by a highly reliable, sensitive device. The differential relay adequately performs these and many other functions which are yet to be determined. It is felt that many new applications for this unit will be found as experience is gained with it.

On a d-c system which has a grounded negative, accidental grounding of a positive motor terminal may not necessarily produce excessive currents, but currents in the positive and negative motor leads will be unequal. This unbalance produces the resultant magnetic flux which is used to operate the differential relay. No electrical connection is needed between the protected power circuit and the relay, since it depends only on magnetic coupling for operation.

Basically the relay consists of a magnetic circuit and a contact operating head. A rectangular-shaped magnetic circuit, completely insulated, is arranged for mounting around the conductors to be protected. A spring-loaded, shock resistant armature and a combination of normally open and normally closed contacts, all mounted in a dust-tight housing, comprise the contact operating head.

Positive and negative conductors, when positioned in the magnetic circuit of the relay, produce fluxes that oppose each other, see Figure 1. Should the current in one conductor become more or less than that in the other, a net, or resultant, flux will be produced. The net flux is proportional to the difference in currents and passes across the armature air gap, see Figure 2. The resultant pull, if sufficient to overcome the spring loading of the armature, will permit the release of the contact trigger to operate the contacts. Once the armature has tripped the contact triggering mechanism, the contacts will be held in that position by a mechanical

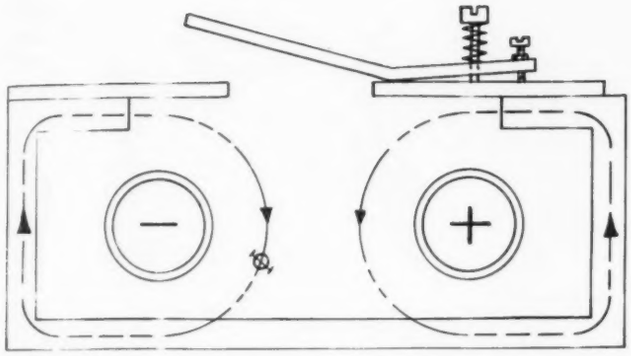


Figure 1 — Single motors may be protected by passing both leads through the relay.

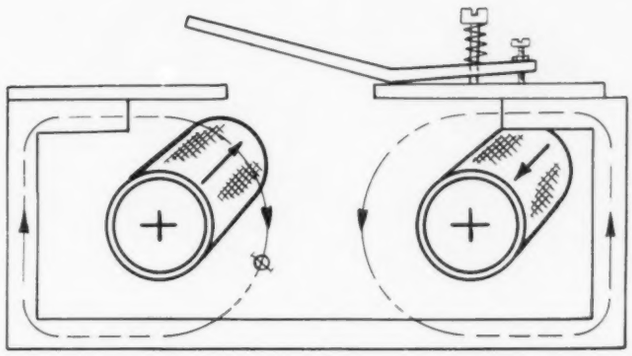


Figure 3 — Duplex drives may be partially regulated by passing one lead from each motor through the relay.

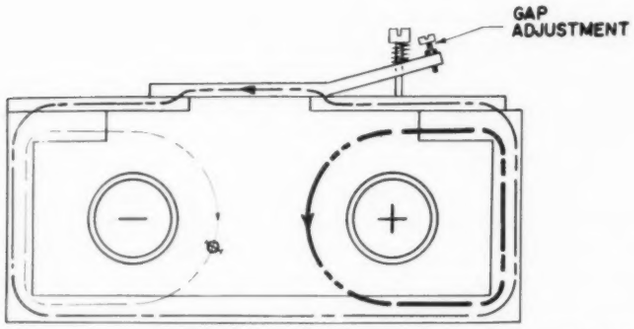


Figure 2 — An unbalance of current produces a resultant flux in the air gap which, if sufficient, closes the relay.

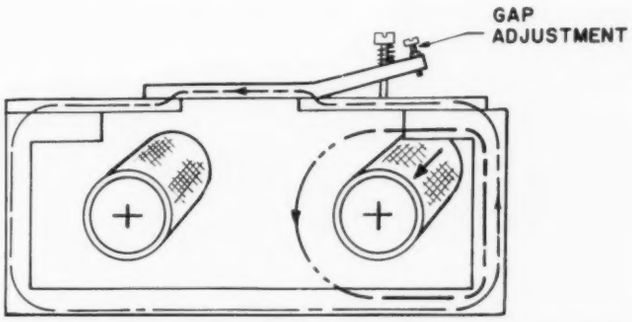


Figure 4 — Unequal motor loadings will produce a resultant flux which, if sufficient, will close the relay.

latch until they are manually reset. A dust-tight, manual reset button is provided in the cover, if desired.

The size of the C core depends on the relay's current rating and conductor size, but the same operating head is used on all units. The relay presently available is rated for balanced currents up to 3000 amp without saturating the magnetic circuit. In this size, the relay has a 6 by 3-in. window opening for conductors or bus. Higher current values are permissible without harm to the relay itself. However, they may cause false tripping due to flux leakages. The tripping value is a function of the difference in the currents flowing in the conductors and is not related to the absolute value of the current flowing. The approximate tripping range of the present relay is adjustable from 150 to 1500 amp with one turn of each conductor through the window opening of the C frame. Increasing the number of turns through the window lowers the tripping range.

Trip value adjustments can be made by changing either the armature air gap or the armature spring tension. Armature gap, as is characteristic of most magnetic devices, is more effective in varying the trip value. The spring provides a vernier adjustment. An increase in the armature gap requires a greater current unbalance in the conductors to trip the relay.

This relay has many uses other than ground detection. It can be installed on duplex drives with two or more motors so that it operates from the circuit feed of each motor or from a pair of motors. The positive wires would enter the picture window from opposite directions and would set up a cancelling or balanced flux, see Figure 3. Whenever one of the motors or circuits draws more current than the other, regardless of the reason for current difference, the relay will operate from the unbalance in flux, see Figure 4. The interlocking can be connected to stop the machine or respective drive until the fault is corrected.

Figures 5 through 7 show the first plant fabricated relays of this kind and their installation. Figure 5 shows a relay with the incoming power leads of an ore bridge going through the picture window. This application was selected due to the magnitude of current in ore bridge operation and the extensive damage which

Figure 5 — The relay has been installed on the power leads of an ore bridge.

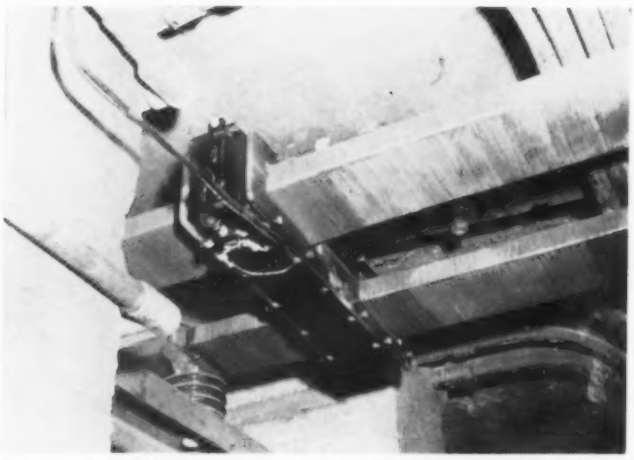


Figure 6 — The relays can be used to protect a large variety of equipment.

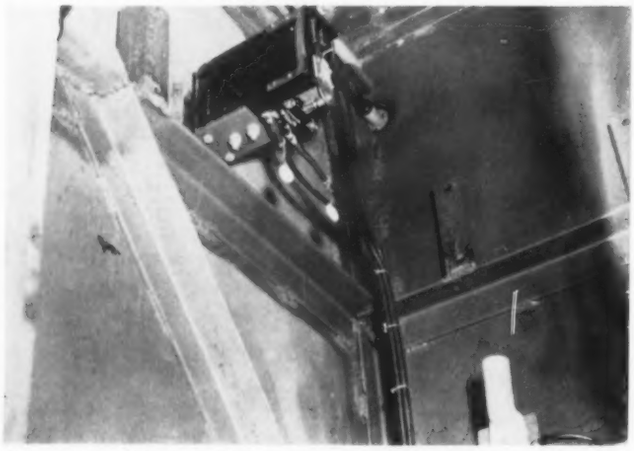
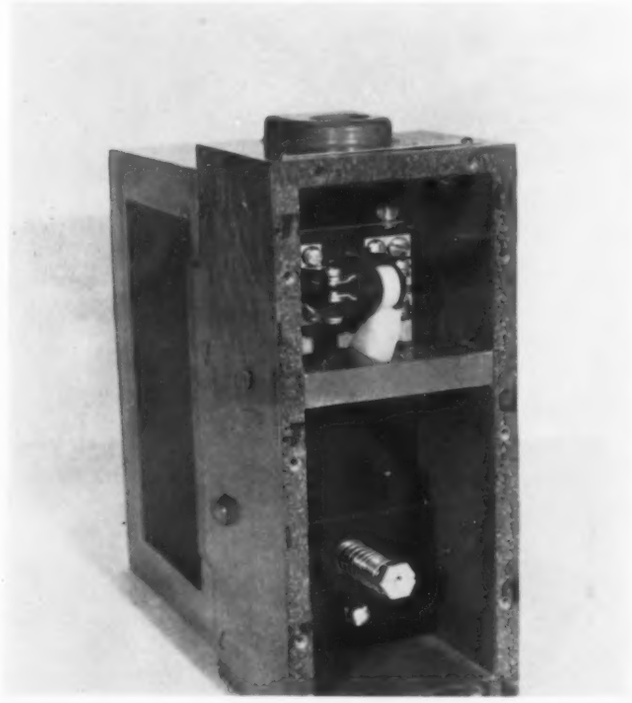


Figure 7 — The relays do not require much space, and they can be installed anywhere that ample room exists.

Figure 8 — The working parts of the relay are protected by a waterproof cover.



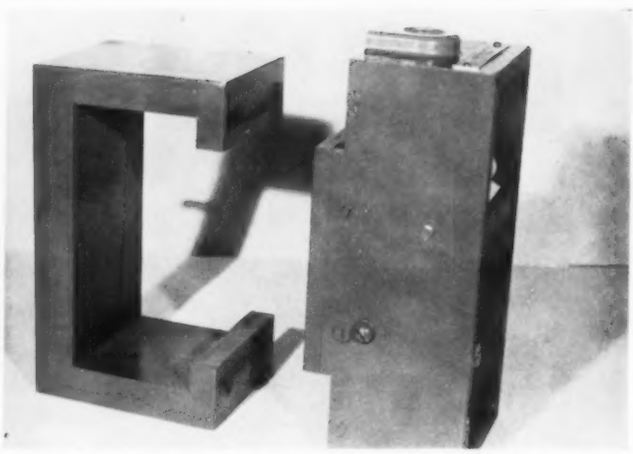


Figure 9 — The relay is easily separated to permit installation or removal of the motor leads.

frequently results when a ground develops. Figure 6 is a picture of a relay on a generator positive and negative feeder. Long lines such as those to third rail installations are subject to accidental grounding and benefit from additional protection. Figure 7 shows a relay which is being installed on incoming power feeders of an open hearth pit crane. Advantages gained here are similar to those mentioned under Figure 5. Figures 8 and 9 show a manufacturer's design of the relay complete with molded head housing and encapsulated C frame.

SUMMARY

It is known that this protective relay will minimize damage to equipment. To date, it has proved successful. No motor that was protected by this relay has been damaged to the extent that was experienced prior to the application of this device. The relay will not prevent grounds or open circuits, but if it is properly installed, it definitely will indicate unbalanced currents produced by grounds, open circuits or unbalanced loading of duplex drives.

Discussion

PRESENTED BY

H. W. DORSET, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

GUNNAR ADOLFSEN, Electrical Engineer, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

ELMER V. EISENBERGER, Electrical Engineer, Alan Wood Steel Co., Conshohocken, Pa.

G. L. MARTHINUSS, Assistant Electrical Engineer, Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

H. W. Dorset: The use of some means of preventing such damage as the author has described has long been discussed, and the operation and protection that this relay has offered has certainly pleased the responsible

personnel at Sparrows Point.

It was installed on many cranes, starting with the holding and closing line ore bridge motors, where large sized mill-type motors had been damaged beyond repair. At various times in the general foremen's meetings, means of preventing this had been discussed. Ratcheting-type relays that would latch out after a given number of operations were discussed, but it was realized that a great deal of damage could be done by recycling, and at the same time overloads might occur that would latch out after three operations when there was no fault.

On one occasion the general foreman of lines and construction came in with a relay similar to the one described which had been used on a bus to indicate overloads of 8000 amp and above. He suggested that such a relay be used in the application described, and the author went to work on this idea and had built in the shop a number of these relays. By trying varying spring pressures and various sizes of steel frames he came up with the answer: a relay that would operate on a low enough value to protect most motors, but would not operate on normal overloads.

Gunnar Adolfsen: It is true that the present available overcurrent devices in many cases are inadequate. The problem of proper protection becomes more difficult as the d-c distribution system increases in capacity, with the resulting increase in magnitude of fault currents.

Can this differential relay be co-ordinated with branch circuit protective devices, in order to obtain selectivity?

Do you experience any unnecessary trips?

Have you developed characteristic curves and calibrated adjustment on the relay?

What methods are used in testing the relay in the field?

Is there any thought being given to the possibility of including the relay as part of the circuit breaker, thereby simplifying the installation and maintenance?

Will this relay be available through any manufacturer?

Elmer V. Eisenberger: Adequate protection of d-c motors has always been a problem. Inherent inaccuracies of overloads, normal response time of overloads, necessity for setting overloads high, the ease with which overload settings can be and are inadvertently increased and improper maintenance are some of the difficulties that everyone has experienced.

The relay described by the author has demonstrated that it will provide protection for grounds on ungrounded systems and unbalanced loadings if properly installed and maintained.

The author indicates that these relays have been installed on crane feeders. If they were installed on feeders feeding more than one crane, tripping of the relay would shut down all the cranes on this feeder. Is this relay rugged enough to be installed on the crane directly, rather than on the feeder?

Has there been any difficulty with persons resetting the relay and applying power without investigating the cause of the tripping?

Member: There is a real need for this relay. However, the greatest application is on grounded negative systems. There are some that do not use such systems, and who may have doubts about grounding the negative. We have had a division in our plant for many years, and one portion of the plant was grounded and the other portion was ungrounded. The last four stations were grounded about five years ago and the results have been excellent.

We feel this way, if we are going to have a ground, let us not wait until we have two of them; let us find it immediately—as soon as it appears, and take the armature out of service to make the necessary repairs.

The relay that has been described is, of course, commercially available. Some have been purchased on ore bridges and for ore crane drives. Making this a standard part of crane control in the larger sizes is being considered. It is felt that its usefulness is worthwhile and that great benefits will be derived from its use.

It is too bad that it cannot in each application, be coupled with a high-speed circuit breaker. Then, the damage would be at a very minimum. However, the present-day contactor is very sensitive, and it can be brought down to within a few amp. Desensitizing is a part of the adjustment on the commercial model.

We have no fear about applying it to the crane or any other piece of electrical equipment. It is as rugged as the contactor or any other piece of equipment on the crane.

G. L. Marthinuss: This relay can be co-ordinated with branch circuit protective devices and will give selectivity.

To date, there have not been any false or unnecessary trips of this relay. The relay, when it has tripped, has definitely indicated trouble or a fault.

As far as developing the characteristics of this relay, we have not had occasion to do so as of this date, however, we were fortunate in selecting steel that performed the function we were seeking.

To test the relay field conditions were assimilated by making use of the leads from two welding machines. The welding cables from these machines were wrapped around opposite sides of the window using two or three turns. This arrangement gave an electrical flow from two directions similar to a positive and a negative through the window. When both welders held their welding electrodes (rods) against their welding surfaces the current flow through the relay was balanced. If either welder removed his electrode the relay immediately operated on the unbalanced current flow. The plant fabricated relays were calibrated by recording current readings while employing this method.

If you refer to large line contactors as circuit breakers, the answer is yes. We interrupt where the circuitry cannot be reclosed.

I should have been more specific and said "individual crane feeders" meaning the source of power from the collector shoes through the main switch to the protective panel on the crane. Figure 6 showed one of the plant fabricated relays installed behind the protective panel located in the operator's cab.

As far as the resetting of the relay is concerned, the reset mechanism is not easily accessible and an electrician must remove a cover before he can reset it. It is his responsibility, of course, to determine what caused the relay to operate and to correct same before resetting the device. A number of instances have occurred when this device has proved itself by preventing extensive damage to expensive equipment. ▲

Experience With The Oxygen Analyzer-Controller

by WILLIAM G. ENDER
Combustion Engineer
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FUEL conscious open hearth operators have always been aware of the possibilities inherent in continuously measuring the oxygen in the flue gases of an open hearth furnace. Tons per hr increases, fuel savings, prolonged refractory life and improved furnace availability have always been the interesting possibilities of an improved combustion practice which might be realized through the use of continuous oxygen analysis of flue gases. Prior to 1959, Bethlehem had no means of accurately assessing these values. Most everyone conceded that such knowledge would have value, but aside from that lone basis of agreement, widely divergent opinions on the reliability and economics of such equipment had been expressed. Several ventures into this field prior to 1957 resulted in failures which did little to build up confidence in the ultimate success of such instrumentation. A common bottleneck was the inability to supply a clean gas sample to the oxygen analyzer in an economically maintenance-free manner.

In March, 1957, Bethlehem Steel's research dept. reopened this subject, and after joint sessions with the fuel division and the open hearth dept., it was agreed to purchase an oxygen analyzer, complete with the sampling system, and to install it on a 240-ton furnace (No. 55) in No. 4 shop. This equipment was installed and put into service in April, 1957.

Prior to any attempt to use the analyzer as a basis of air or fuel control, the fuel division's primary concern was to be sure that it had a workable instrument capable of continuous operation under feasible maintenance conditions. Therefore, it was decided that the first step would be only to sample and to continuously record the oxygen, without attempting fuel or air control. The sampling point was located at the same place where the exhaust gases were manually sampled, in the rear uptakes, about three ft above the floor level.

Figure 1 shows the sampling tube and the stand in its sampling position. The sample point is about two ft inside the uptake wall.

Figure 2 shows the analyzer and the recorder. These are located beside the furnace operating panel about 75 ft from the furnace sampling point, across the charging area. The gas sample travels about 100 ft from the sampling floor point, to the point of analysis, permitting continuous sampling every 20 sec.

It might be of interest to review some of the maintenance experiences during this shakedown period. For the first month of operation, maintenance on the sampling system averaged about eight hr per week, while analyzer maintenance was negligible. Maintenance time on the sampling system dropped to approximately one hr per week after water pressure and water hardness troubles were eliminated. River water, at 60 ppm hardness, was substituted for spring water which averages 300 ppm hardness. This change was made on the spray tube only; spring water remained on the probe cooling chamber. The lower temperatures maintained in the probe cooling chamber permitted only negligible lime deposition, but the steam heating of the spring water in the spray tube, caused by the steam jet pump, precipitated rapid lime formations. Thus, it was necessary to shut down and acid clean the jet pump assembly every other day. After these problems were resolved, maintenance dropped to, and has remained at, what is considered an economically workable level.

During the period from April, 1957 to June, 1958, while analyzing and recording functions were performed, six interesting facts were established.

First, instrument reliability was proved. Constant checks against the orsat and the heat prover showed results consistently uniform.

Second, the use of a CO analyzer in conjunction with the oxygen analyzer showed this to be true: consistently very little difference exists between the CO percentage measured by the CO analyzer and the percentage of combustibles indicated by the heat prover.

This indicates that CO makes up practically all the measurable combustibles in the waste gases. Also, it was established that an O_2 level of one per cent will hold combustibles to a maximum of 0.6 per cent except for the start-hot-metal to finish-lime-boil period.

Figure 3 was plotted from the gas analysis of more than 100 heats and establishes 0.6-per cent CO with O_2 controlling at one per cent. These periods are from start charge to hot metal, and from finish lime boil to tap. The period from start hot metal to finish lime boil is illustrated by the curve in Figure 4 and reveals quite a different picture. To reduce CO to 0.6 or 0.7 per cent it is necessary to control O_2 at two per cent. Therefore, it was decided that a control point somewhere between one and two-per cent O_2 would produce the best results.

Third, the standard practice of manually setting

furnaces at three per cent excess O_2 before hot metal satisfied conditions for only short periods of time. During start charge to hot metal the O_2 ranged from two to five per cent, with high oxygen readings noted during prolonged door openings. Then the addition of hot metal absorbs all the O_2 present and drives the CO above ten per cent. During the flushing period the fuel was experimentally reduced as much as 150 gal before O_2 appeared in the downtake gases. From start to finish of lime boil, the O_2 ranges from one to four per cent, with CO always present at about 0.5 per cent. These conditions were not new, but they had not previously been recorded, as only the heat prover or orsat were available. Now, complete records of each heat graphically emphasized these unbalanced furnace conditions.

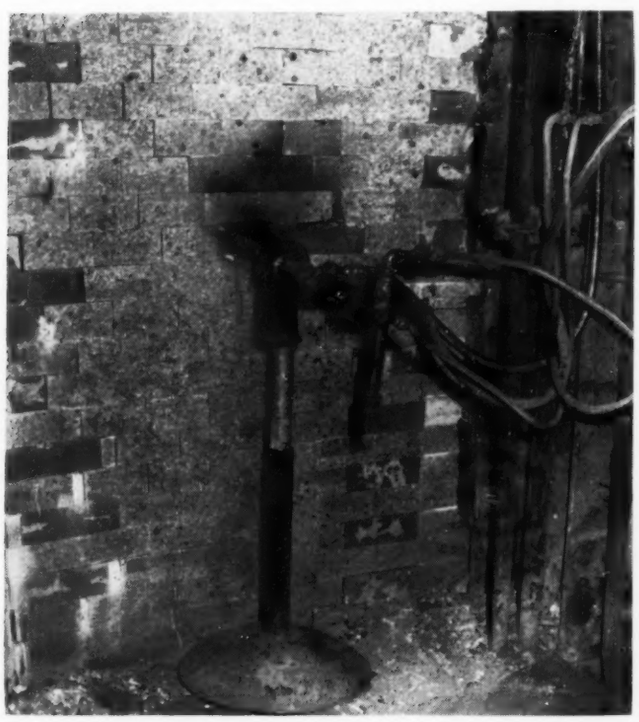
Fourth, it was noted that the CO recorder went to the top of the scale on each reversal and remained there for about one min. This was caused by putting the fuel on too fast, a 15 to 20-sec interval. Retarding the "fuel on" time to 35 sec eliminated this condition.

Fifth, it was revealed that this particular furnace (No. 55) on a maximum 625-gphr firing rate, operated with an air deficiency 30 per cent of the time due to inadequate fan capacity.

Sixth, manual control of the fuel and air, in an attempt to hold the O_2 between one and two per cent, was tried, but a short trial period of one week proved this impractical, with fuel and air changes sometimes required as often as every reversal.

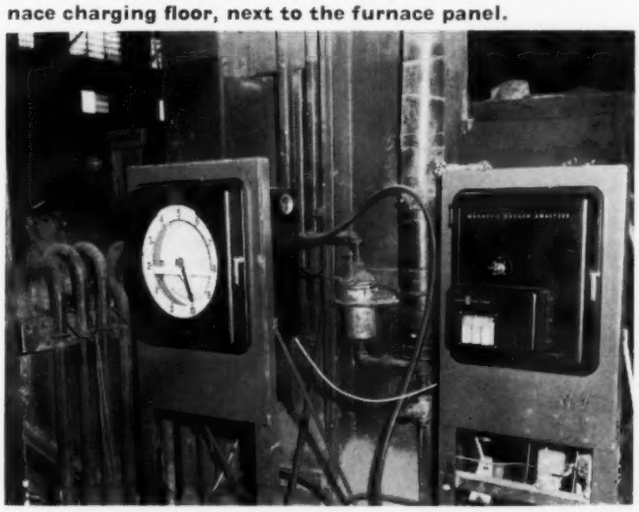
Due to insufficient fan capacity at No. 55 furnace, the analyzer was moved to No. 43 furnace in No. 2 shop. This 160-ton furnace was known to have adequate fan capacity. A controller was also installed for air requirements as dictated by the O_2 analyzer. These changes were made in June, 1958. The analyzer was set to control the combustion air to automatically hold two per cent in the outgoing gases. This immediately posed an interesting problem. During the charging period, on maximum fuel firing, the metered combustion air remained at low flow instead of rising to the high flow normally needed for combustion at this firing rate, and still the analyzer was recording two per cent O_2. Obviously, sufficient air was infiltrating through the open doors to cause our combustion air fan to cut back to maintain the two per cent O_2. Close observation during these periods revealed poor flame characteristics due to air deficiency and the lack of preheated air at the burner. Higher furnace pressure was then tried in the hope that air infiltration could be minimized. This failed when the charging machine operator's visibility became impaired. The next move was to change the set point from two to three per cent O_2. This increased the combustion air flow enough to obtain satisfactory flame characteristics. Final settings were re-

. . . . open hearth flue gas analysis on a continuing basis points up furnace deficiencies and limitations, while permitting regulation of either the combustion air or the fuel to hold flue gas combustibles within a predetermined limit. Shortened heat time and increased refractory life are indicated extra dividends . . . .



◀ **Figure 1 — The sampling tube was inserted through the uptake wall at a point which seems to provide the most accurate sample.**

▼ **Figure 2 — Recording instruments are located on the furnace charging floor, next to the furnace panel.**



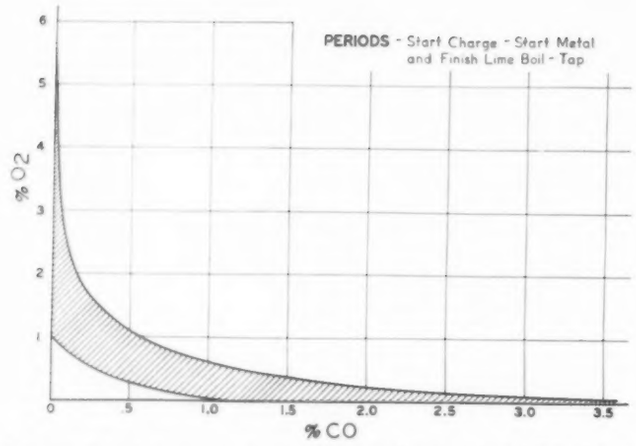


Figure 3 — A one-per cent O_2 control point held CO below 0.6 per cent during the part of the heat cycle.

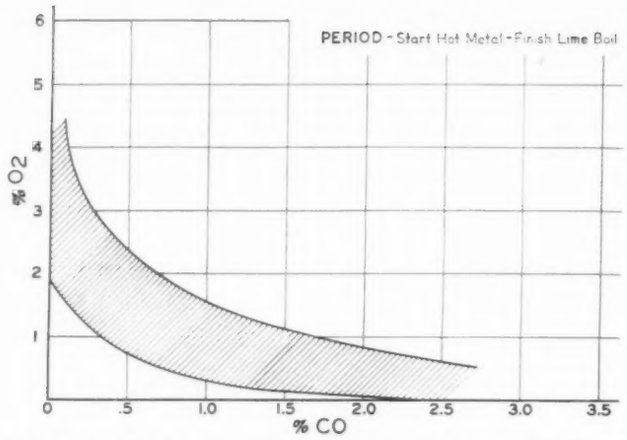


Figure 4 — During part of the heat cycle it was necessary to control O_2 at two per cent if the CO was to be held at or below 0.7 per cent.

solved at three per cent during the charging period with a trial 1½ per cent being used for the rest of the heat. With these settings a 10-day "off control" period was compared with a 10-day "on control" period.

From Table I it is evident that despite a longer charge-to-tap time, a lower percentage of hot metal and a light drop in tons per hr, a definite savings in fuel was obtained. The operational data obtained to date, however, was too meager to be classified as anything other than indicative. The important progress was that, despite some changes and readjustments, continuous analyzing, controlling and recording the oxygen in the flue gases was on an operational basis.

Shortly after the preceding work was concluded, No. 3 furnace came off due to economic conditions, and the instrumentation equipment was returned to No. 55 furnace in October, 1958. Since combustion air was in limited supply on this furnace, the setup was made on fuel control rather than on air control. A 10-day on control period was run with O_2 controlled at a 1½ per cent O_2 throughout the heat. The furnace was set to fire a maximum of 625 gal of oil equivalent. When it was necessary to reduce the firing rate, the combustion air flow was manually lowered and the fuel followed at the rate needed to maintain the O_2 setpoint. It should be noted at this point that a temporary compromise on total fuel control was made by controlling only the coke-oven gas. The fuel balance on these furnaces consists of 70-per cent coke-oven gas and 30-per cent pitch blend. Due to the experimental nature of the work it was decided to control only the coke-oven gas. The more extensive phase of complete fuel control would be entered only after it was proved that the end results justified the means.

This partial control permits the manual adjustment of the pitch blend flow to maintain the proper total fuel should it be necessary to reduce the gas flow below 200-gphr equivalent. Gas flows of less than 200-gphr oil equivalent have a tendency to tail upward and endanger the roof above the burner. Thus, this 200-gphr flow has been set as a safe minimum for gas firing. The liquid fuels take over at the lower gas flows. This gives automatic fuel control on flows between 200 and 625 gphr. Normal firing is above the 200 gphr minimum 90 per cent of the time, or except during the lime boil. Thus, this restriction has had little or no effect on the experimental work.

The results of the 10-day on control period with fuel control was completed satisfactorily. After a joint meeting with research, the open hearth dept. and the fuel division, it was decided to evaluate the use of fuel control by alternating off and on control for 10-day periods for the duration of a furnace campaign. An attempt was made to hold a standard charge on this furnace, but after a short period this was found to be impractical and had to be abandoned.

Figure 5 shows a comparison of fuel consumptions between the off and the on control periods for the furnace campaign. The on control gas flow curve indicates a definite fuel savings, cutting back as much as 150 gphr (oil equivalent) under the manual off control operation. During this campaign close follow-up revealed certain practices which, while normal for conventional firing, could be altered to advantage on controlled heats. When a furnace runs hot, the normal practice for cooling is to maintain excessive air by either lowering the fuel or raising the air. Since this furnace was on on control any lowering or raising of the air correspondingly altered the fuel to maintain 1½ per cent O_2. In line with past practices, the instrument was taken off control and the air and fuel were positioned manually to give the desired cooling effect. The recommended method of lowering air on control would have been to lower the fuel to the desired rate while still maintaining the proper O_2. This would save fuel and eliminate the overcooling tendency of the manual practice. Another factor not conducive to realizing the full potential of the O_2 analyzer was the 10-day on and

TABLE I
Operational Results—No. 43 Furnace

	Off control, 9/21/58 to 9/30/58	On control, 10/1/58 to 10/10/58
No. heats	24	23
Tons	5596	5541
Charge-to-tap, hr-min	8:38	9:26
Tap-to-tap, hr-min	9:56	10:27
Tons per hr	23.3	23.1
Hot metal, per cent	56.82	53.83
Coal per ton, lb	261.3	247.9
Oil, gal per ton	23.5	22.3
MBtu per ton	3527	3347

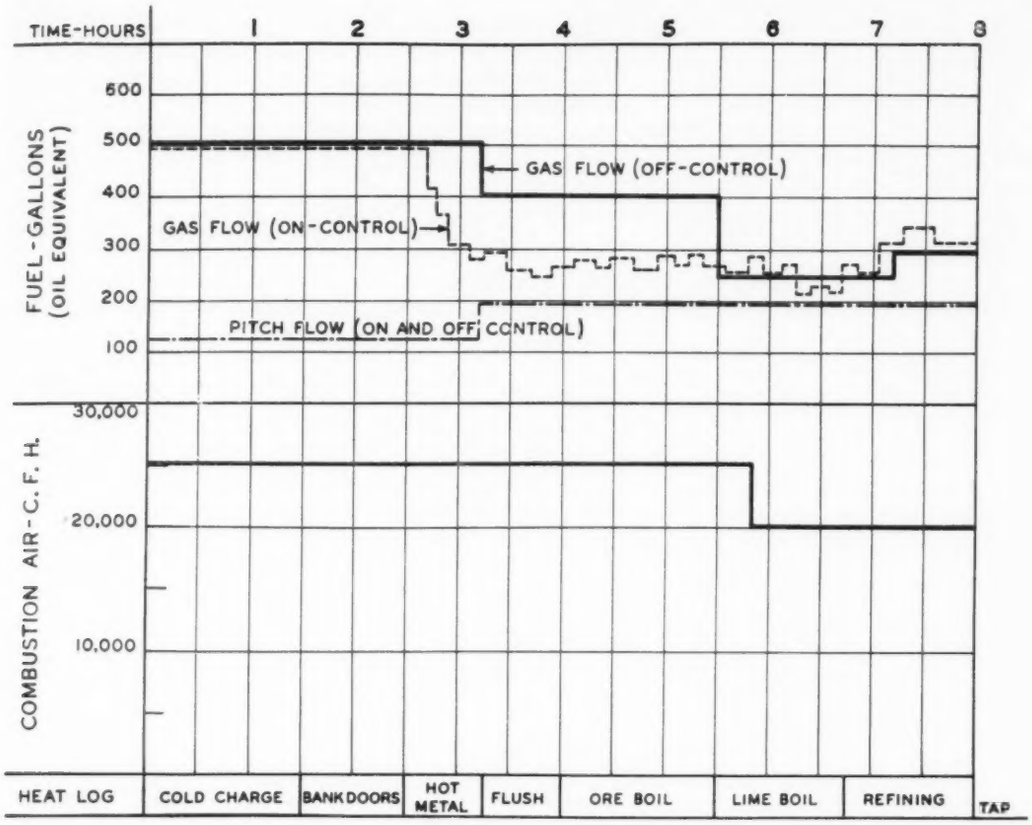


Figure 5 — Only the gas flow was adjusted on the control furnace as it was desired not to use extensive control modification during the test program.

10-day off policy. This policy did not give the operators sufficient time to familiarize themselves with the characteristics of operation on O_2 control. A furnace on O_2 control runs clearer and hotter than a furnace without O_2 control. It is important that the operator becomes familiar with these potential advantages. To promote this familiarity, it was decided to place No. 55 furnace on constant O_2 control for a full campaign.

This was accomplished on April 20, 1959. Fortunately No. 54 furnace, adjacent to No. 55 and in all physical respects identical, was rebuilt about the same time as No. 55. This provided an excellent basis for comparison: No. 54 furnace on complete manual operation and No. 55 on full continuous O_2 control. Figure 6 is an example of the graphs obtained during heat comparisons.

Table II shows a summation of performance compiled from our regular monthly production sheets, covering

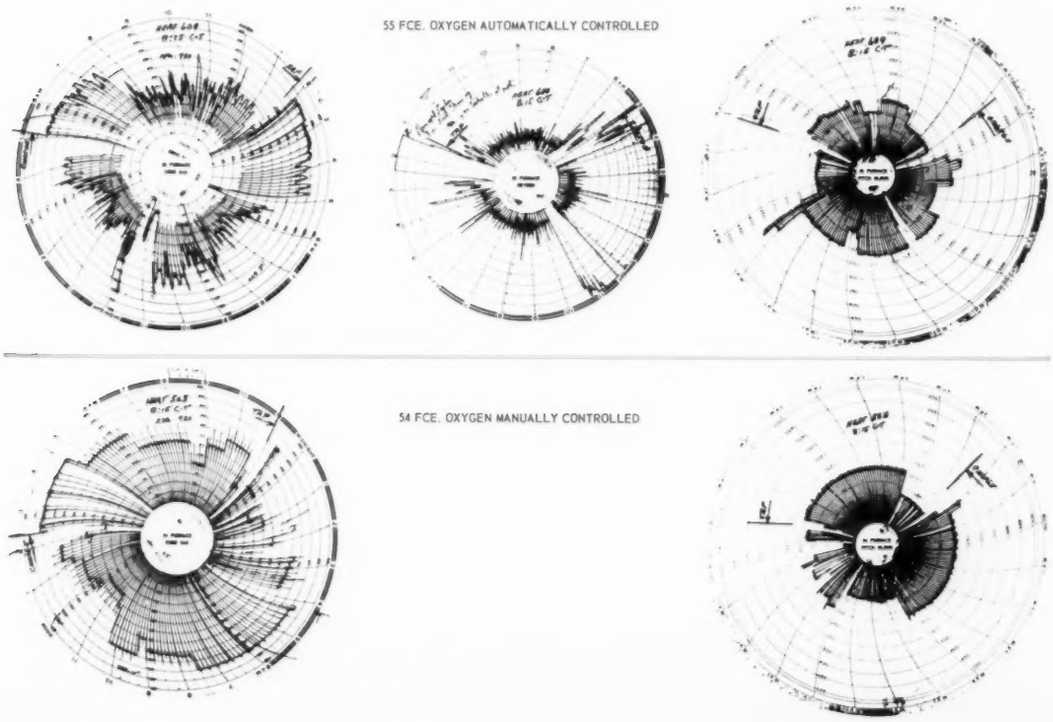


Figure 6 — The graphs illustrate data obtained during the 8-hr-15 min heat comparison detailed in Table III. The graphs left to right are coke-oven gas flow, per cent oxygen and pitch blend flow.

TABLE II
Operational Comparison

	No. 55 furnace, Oxygen control	No. 54 furnace, no oxygen control
No. of heats		
May	85	84
June	70	70
Charge-to-tap, hr-min		
May	7:46	7:48
June	8:50	8:54
Tap-to-tap, hr-min		
May	8:45	8:51
June	10:17	10:17
Fuel, mm-Btu per ton		
May	2.8	3.0
June	3.1	3.5

May and June period, the last two full months of production prior to the strike. There was only a slight improvement in heat time for heats made with O_2 control while the reduction in fuel consumption for the 2-month period is substantial, about 300,000 Btu per ton. This represents about a 15¢ per ton savings in fuel costs.

To further check these fuel savings all heats during May and June of identical charge-to-tap time, No. 54 furnace vs No. 55 furnace were collected and the fuels tabulated. Fuel savings on No. 55 furnace, O_2 controlled, were calculated to be 14¢ per ton, very close to the 15¢ per ton figure obtained from the regular monthly production sheets. Charging times on all compared heats were within ten min of each other, and the less than one-per cent total fuel variation did not materially affect the results. Table III illustrates the difference between the manual operation on No. 54 furnace and the controlled operation on No. 55 furnace for identical charge-to-tap time heats.

With a 7-hr heat, No. 55 furnace had a 61.1-per cent hot metal charge and No. 54 had a 63.8-per cent hot metal charge. The controlled heat (No. 55) fuel cost was 16¢ per ton below the manual operation on No. 54 furnace.

An 8-hr charge-to-tap time heat with No. 55 furnace (controlled) making a 15¢ per ton fuel cost savings despite 3.6 per cent less hot metal than No. 54 furnace is also detailed.

The 8 hr-15 min heat shows a 17¢ per ton fuel cost advantage for the controlled furnace with the hot metal percentage the same for both furnaces.

The 8 hr-45 min heat shows a 12¢ per ton fuel cost advantage for the controlled furnace. Again this is a slight hot metal advantage for the uncontrolled furnace, 49.4 per cent against 47.1 per cent on No. 55 furnace. No. 54 furnace, on manual control, was evidently handled extremely well to hold the fuel cost difference to only 12¢ per ton higher than the controlled furnace.

The 9-hr heat charge-to-tap time, which indicates how expensive a manual operation can get, is 42¢ per ton costlier than No. 55 furnace's automatic oxygen control. The hot metal percentage difference was slight, 1.1 per cent favoring No. 55 furnace.

SUMMARY

The experience with O_2 analyzers can be briefly summarized by:

1. O_2 analyzers can be operated with confidence of a correct analysis and without fear of a prohibitive maintenance cost.
2. It is not unreasonable to expect a six-per cent fuel savings with O_2 control.
3. On furnaces with an adequate air supply it is believed that advantages would include shortened heat time as well as improved fuel consumption and refractory life.

Waste gas O_2 control has definitely proved itself as a reliable fuel saver, and experiments are being continued to arrive at definite answers on reduced heat times and refractory savings.

Discussion

PRESENTED BY

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WM. DICKINSON, Combustion Engineer, Bethlehem Steel Co., Sparrows Point, Md.

JOHN J. HANNIGAN, Superintendent, Open Hearths, Alan Wood Steel Co., Conshohocken, Pa.

WILLIAM G. ENDER, Combustion Engineer, Fuel Div., Bethlehem Steel Co., Bethlehem, Pa.

R. S. Hagerty: An oxygen analyzer is a very important tool in the open hearth operation. At Fairless

TABLE III
Charge-To-Tap Furnace Comparison*

Furnace	Date	Heat	Tons	Time, hr-min	Gas		Pitch		MBtu per ton per heat	Fuel cost per ton	Hot metal, per cent
					Mcu ft	MBtu	Gal	MBtu			
55	6-22	609	253	8:15	720	394,906	1500	240,327	2511	$1.43	61.5
54	6-21	563	245	8:15	920	540,602	1400	224,305	2975	$1.60	61.8
55	5-5	483	244	7:00	640	351,027	1200	192,262	2227	$1.27	61.1
54	5-6	444	239	7:00	720	394,906	1300	208,283	2524	$1.43	63.8
55	6-17	597	242	8:45	880	482,662	1600	256,349	3054	$1.78	47.1
54	6-17	553	241	8:45	1000	548,480	1600	256,349	3340	$1.90	49.4
55	6-21	606	244	9:00	760	416,845	1600	256,348	2759	$1.57	57.4
54	6-20	560	224	9:00	960	526,541	1600	256,348	3495	$1.99	56.3
55	6-12	585	245	8:00	760	416,845	1300	208,283	2552	$1.45	52.3
54	6-11	539	248	8:00	880	482,662	1300	208,283	2786	$1.60	55.9

* Data were gathered using identical charge-to-tap times.

it is felt that oxygen analyzers are important on most types of furnaces, and as evidence of their popularity analyzers will be installed on the new soaking pits. There have also been good results using them on blast furnace stoves. In fact, such installations are to be made permanent.

Is the furnace on control during the charging period? If so, how is control affected by door openings, changes in furnace pressure and sudden changes in fuel input? Do these conditions create sudden changes in waste gas analysis of such frequency and duration that the controller can never make the necessary correction to maintain the desired oxygen content?

How repetitive is the gas analysis from the period from start charge to hot metal? How was the present sampling point determined?

At Fairless a standard probe is used, which is obtained from the supplier. After being used for a short period of time, the probe sags. Have you experienced that problem?

Wm. Dickinson: At the Sparrows Point plant, back in 1950 or 1951, a continuous oxygen analyzer was tried. At that time the sampling systems had not been well developed, and this first test program was short lived. Recently two oxygen analyzer units have been obtained on consignment from two separate companies and have been put on two furnaces in the No. 4 open hearth shop.

John J. Hannigan: Shortly after World War II, steel men started to recognize the tremendous potential they had in the open hearth furnaces, if they made a few changes. Two changes had to do with the use of oxygen and combustion control. Up until that time, if an open hearth operator had pressure and fuel charts, he had a lot of information. Today, there are few furnaces that do not have at least an air recorder chart; a steam, air, or gas chart for atomization, whichever is used; some form of oil controls; a temperature recorder chart; a furnace pressure chart and an electric clock. There are many furnace operators, who can only read the clock, and sometimes we doubt this when checking start and quit times.

The installation and maintenance of this equipment was quite expensive, to put continuous flue gas analysis on also was almost prohibitive. However, some operators did recognize the tremendous potential that continuous analysis presented for fixing firing rates during specific periods of furnace operation.

Continuous analysis had another group of dissenters in those operators who were reluctant to measure excess air because their shops were under checkered. This resulted from enlarging furnace hearths, but doing nothing with checkers because of lack of space. These men really started the use of combustion oxygen and found that in most cases they could not charge furnaces fast enough. These men also knew, from experience, that running a flame with an air deficiency causes formation of free carbon particles which increase luminosity of flame and therefore temperature radiation. This increased combustibles to the checkers, made them run hotter and eventually clog up due to soot with a resultant furnace blowing and heat slowdown.

These were the two big obstacles combustion engineers encountered, which were overcome by persistency of purpose. The author showed a steady oil flow chart, and a very rapid changing gas flow chart, that changed immediately with furnace conditions. This type of control or fuel savings could never be achieved without automatic controls. The author stated that this savings represents 6 per cent. This is a tremendous amount of money in the steel industry.

Since refractory savings are somewhat intangible, it is questionable whether there are measurable savings due to controls: many operators have very fine furnace life without controls.

Has any attempt been made to maintain flame length or is this maintained as a result of controls?

Have these air controls been used in presence of oxygen usage, either roof lance or lance immersion?

Would combustibles vary using oxygen with carbon content of metal?

Has any checker temperature variation taken place?

Does the savings warrant at least investigation of installation on all furnaces?

William G. Ender: On air control, we either must go off control during door openings or set the O_2 control high enough to maintain the preheated air at the burner. It is preferred to setup the O_2 control point to three per cent and remain on control.

On fuel control (the preferred type of control at present) we rarely go off control. Making bottom, or if the gas firing rate drops below 200 gphr and due to the condition of the bath the first helper is reluctant to lower his pitch, are the only two justifiable reasons for off control. As noted on the O_2 chart (Figure 6) the O_2 set point is maintained fairly consistently.

We have encountered stratification particularly at points above the present sampling point. The present point was located by spot sampling and it is felt that the present point, below the bridge wall, is directly in the waste gas stream and provides the most reliable sample.

The probes sag only if the water pressure drops below 25 psi or if lime deposits are allowed to accumulate sufficiently to reduce the water supply. This has not been a problem for quite some time. We have occasionally been the victims of water shutdowns and then the probes do not sag, they disappear. Vendor's probes are being used.

Flame length on liquid fuel is controlled by steam and on gas by volume. No attempt to control by excess air has been tried.

We have not had experience with these controls on either roof lance oxygen or immersion oxygen. Sparrows Point is believed to be contemplating control on one of their furnaces.

No measured checker temperature variation has been noted; however, inspection prior to the last rebuild revealed icicles on the fan tail arch. This was never noticed before and it was concluded that with complete combustion upstairs, icicles were able to form in places that previously would not permit solidifying due to the previously higher temperatures caused by after burning downstairs.

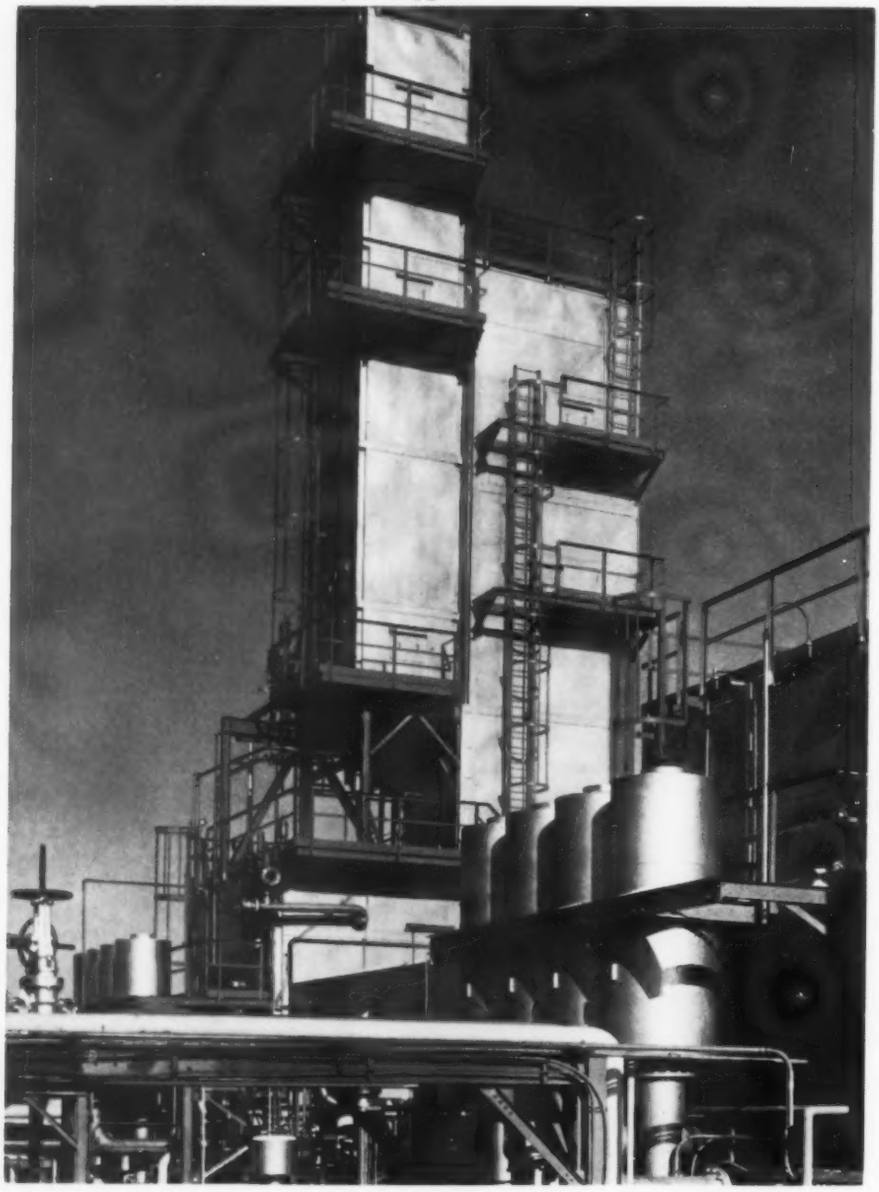
The anticipated savings certainly warrant investigation for further installations. The cost is presently being developed: 60-cycle power extension, water requirements and unit costs are being established. Maintenance and operating costs have been developed with over a year's actual operation experience. ▲

Low-Pressure Oxygen Plant Has Novel Features

AN oxygen plant owned jointly by Hydrocarbon Research and Wheeling Steel Corp. was recently unveiled.

The new plant, a highly-integrated processing operation, besides producing over 400 tons per day of gaseous oxygen for Wheeling Steel, also produces high-purity liquid oxygen and high-purity liquid argon. The liquid oxygen and liquid argon will be marketed to outside consumers by a national gas distributor.

Figure 1 — The plant is composed of two 200-ton per day oxygen units, one of which is combined with an argon recovery unit for production of liquid argon. This unit also produces the liquid oxygen.



At present, vapor oxygen is being pumped more than three miles through a 12-in. pipeline to Steubenville, Ohio, where it is used by Wheeling Steel in open hearths for scarfing and for general plant usage. The oxygen is employed in the open hearths for combustion and decarbonization.

About half of the total output of vapor oxygen is to be used for making open hearth grade steel by the Oxygen-Vapor process in a pair of 15-ton acid converters operated by Wheeling at Mingo Junction. These converters produce steel for skelp billets for continuous weld pipe and slabs for sheets to be drawn or formed.

The plant is the first furnishing high-purity oxygen to the steel industry to employ the reversing exchangers developed by Hydrocarbon Research. The effectiveness of these exchangers has been demonstrated in oxygen plants for the chemical industry, where they were first introduced by HRI. The exchangers are designed to afford safety and dependability of operation.

The reversing exchangers in the Mingo Junction plant eliminate periodic shutdowns for deriming. This insures operating dependability since any water or carbon dioxide present is completely removed in the exchangers. The reversing exchangers also remove contaminants from the atmospheric air to a greater degree than other systems. This affords greater safety since only clean, dry air can enter the process.

FIRST Five-Zone, Continuous Reheating Furnaces were *built by RUST, in a 68" hot strip mill at a large eastern steel plant*

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Three-Zone, Continuous Reheating Furnace → 1929
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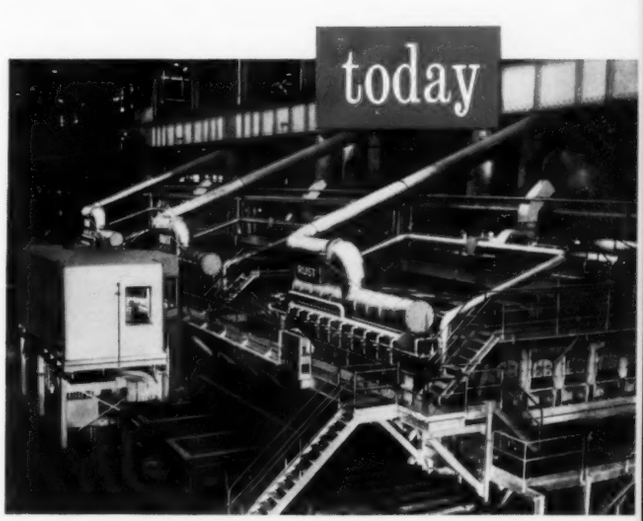

Modern, Five-Zone continuous reheating furnaces in 56" hot strip mill at a large eastern steel plant

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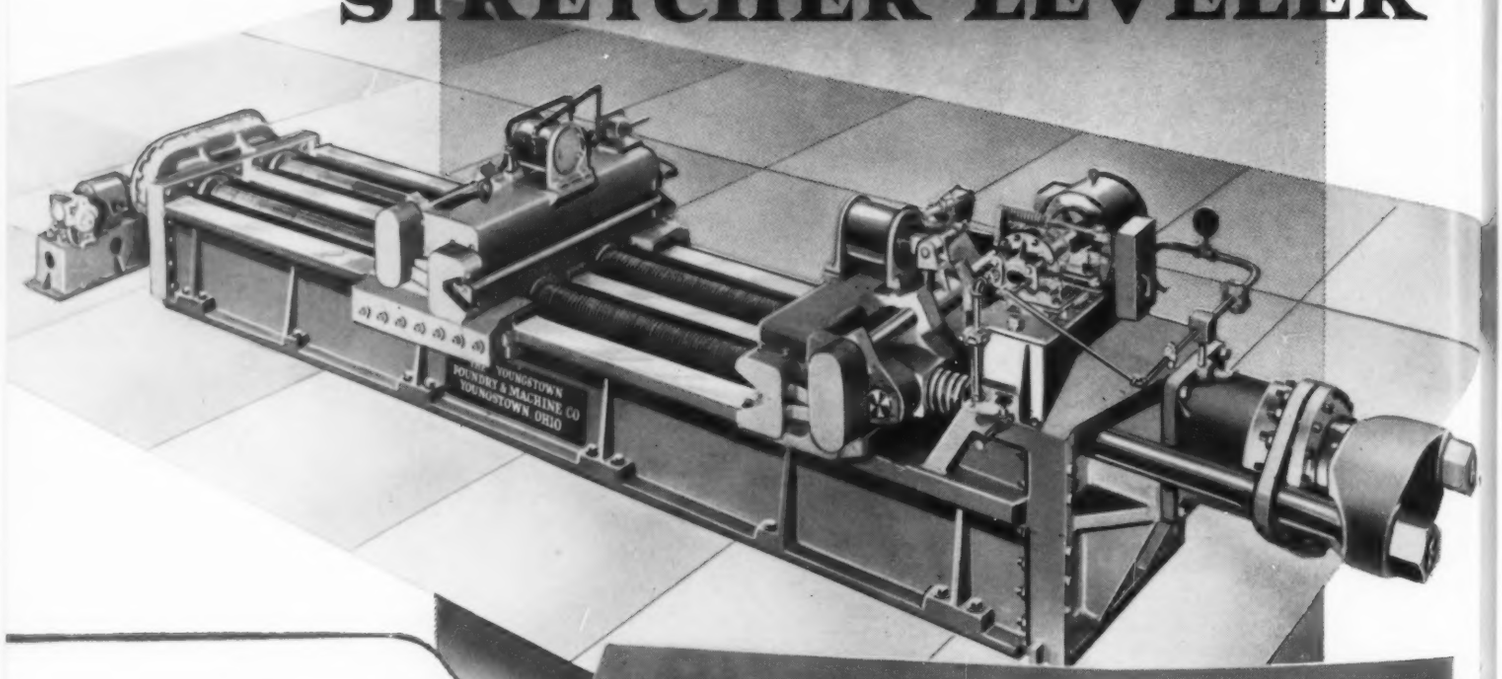

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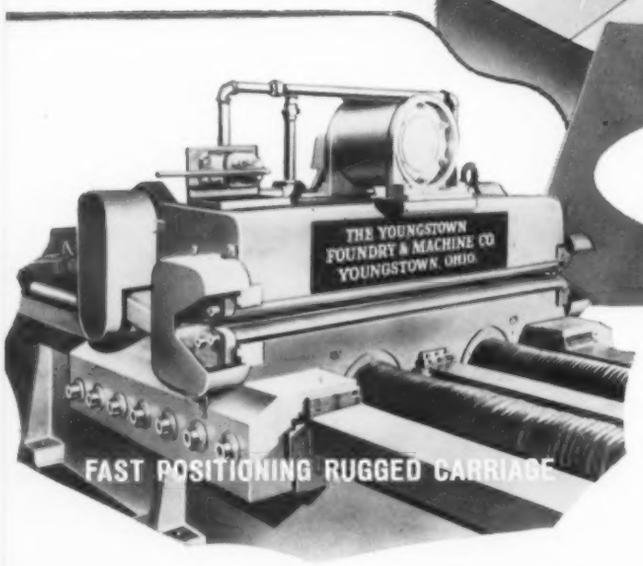

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The plant consists of a pair of 200-ton per day units, each packaged in its own "cold box." The cold boxes, made of steel, enclose all pressure vessels, heat exchangers, valves and piping, and are filled with rock wool insulation to exclude heat.

Aluminum alloys and stainless steel are used extensively in the new oxygen plant to withstand the extreme cold encountered during operation. Aluminum maintains its ductility, resists shock and improves in strength at extremely low temperatures. Stainless steel, with its great strength, is used for equipment operating at high pressures. Exchanger tubes, expander piping, large gate valving and check valves are of stainless.

Novel cryogenic couplings, developed by Hydrocarbon Research, are used throughout the plant to join aluminum pipelines directly to stainless lines by welding. These transition couplings eliminate the need for flanging. The absence of flanges cuts initial and maintenance costs, results in greater compactness, and, most important, safeguards against leaks.

Of all-welded construction, the plant was built by the latest fabricating methods. Shop-assembled sections were readily joined at the plant site. A minimum of field welding was required for the interconnecting piping and the joining of the matching seams of the cold boxes. Most other welding had already been done in the shops to assure closer quality control.

A highly efficient low-cost operation, the Mingo Junction oxygen plant has exceeded its design capacity and produces oxygen of up to 99.7 per cent purity. ▲

Electric Furnace Downtime Reduced By Refractory Placement Method

A METHOD of fettling electric furnaces, which can reduce downtime by up to 90 per cent and save up to 40 per cent in refractory material, has been announced by Blaw-Knox Co.

The latest innovation follows closely the firm's introduction of a pneumatic system for handling and placing dolomite, ore, lime and other materials in open hearth furnaces.

Both systems are part of a continuing effort to match and, where possible, anticipate requirements of modern steelmaking.

Basic component of the new electric furnace fettling method is a patented Centrithro machine which can be used with or without the pneumatic conveying system to replace refractory guns, shovels and other fettling equipment.

The unit includes a cone-shaped hopper that is lowered into the center of the furnace to fettle all eroded sections in the bottom and at the slag line. Mounted above the machine is a variable-speed air motor, attached to a shaft that spins a rotor at the bottom. Lowered by crane into a top-charged furnace, the machine's rotor spins counterclockwise to distribute refractory material. Centrifugal force of the spinning rotor causes the material to slide along the furnace wall, searching out and then settling into eroded areas.

In one installation, the unit has logged 56 heats and has been in and out of a 75-ton, 16-ft diameter furnace so fast during the fettling process that the paint is not even scorched, resulting in a 90-per cent saving in downtime, from 20 to two min.

Also, only 2400 lb of refractory material was required per heat in comparison with the former total of 3000 lb. This is a saving of 20 per cent per heat. Blaw-Knox estimates that with other material, containing greater fines, the saving could run as high as 40 per cent.

The 5000-lb capacity fettling machine used in the installation is five ft high with diameters of 42 in. at the top and 24 in. at the bottom. However, size and capacity of the Centrithro can be easily increased to handle larger furnaces. ▲

Figure 1 — In service the unit is lowered by a crane into the center of a top-charged electric furnace.

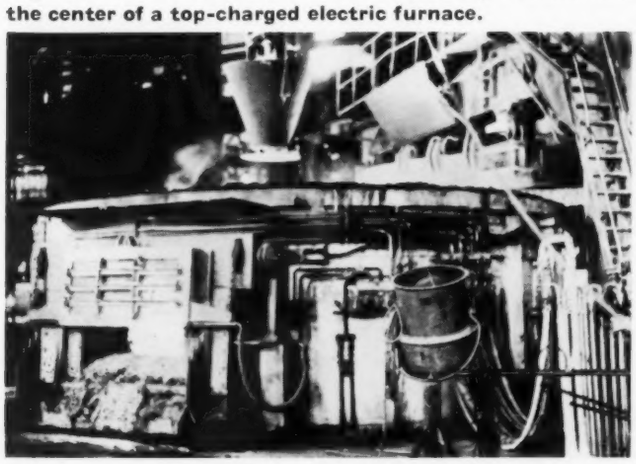
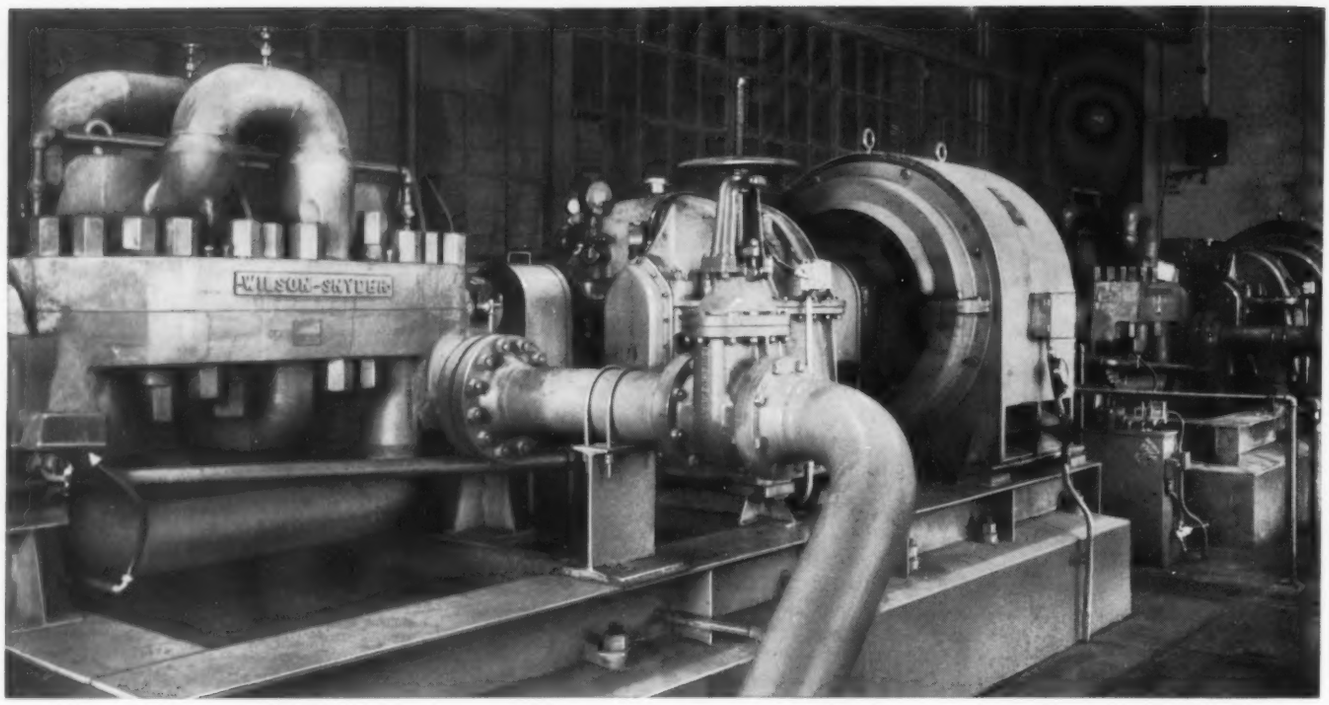


Figure 2 — The refractory material is flung against the side of the furnace by centrifugal force.



Ford uses Wilson-Snyder High Pressure Descaling Pumps in modernized hot strip mill

Shown above are two Wilson-Snyder heavy duty 6-stage 3,900 RPM centrifugal pumps in Ford Motor Company's modernized hot strip mill. Driven by 2,000 HP, 1,800 RPM motors through speed increasing gears, these powerful pumps deliver water in excess of 1,600 psig to five locations in the mill, two of which have double spray headers top and bottom. This is one of the highest pressure descaling installations in operation anywhere.

Wilson-Snyder also makes complete line of reciprocating pumps

For relatively lower capacities and discharge pressures to 10,000 psi., Wilson-Snyder has a complete line of reciprocating pumps which includes triplex and quintuplex single-acting plunger types, as well as duplex double-acting pumps. These pumps are extensively used in hydraulic system applications and low capacity descaling operations.

Whether you are planning a complete modernization program or new construction, Wilson-Snyder welcomes an opportunity to work with you. We have the engineering "know how" and the experience to save you time and money in selecting and setting up a modern, efficient descaling system. We are prepared to furnish and install the complete system, including the accumulator, charging compressor, headers, strainers, nozzles, spray valves and other necessary components.

We invite your inquiry and will be pleased to quote on your particular requirements. Write or call Wilson-Snyder Works, Oil Well Supply Division, United States Steel, Braddock, Pennsylvania, or your nearest Wilson-Snyder representative.

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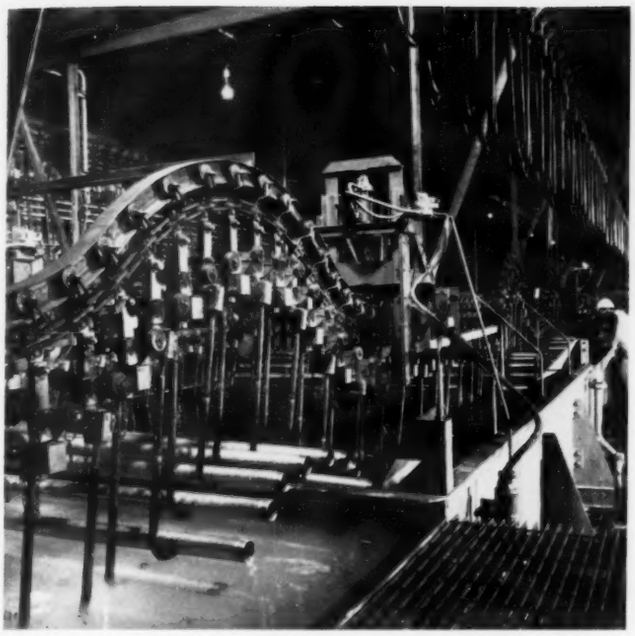

Figure 1 — A carrier system automatically dips the conduit into the various solutions.

Figure 2 — A coupling and a thread protector are placed on each piece of conduit prior to bundling.

Steel Conduit Coated on Automatic Galvanizing Line

ONE of the world's most modern electroplating lines is now in operation at the Ambridge plant of National Supply Div. of Armco Steel Corp.

With this equipment, electrical metallic tubing, a thin-walled steel conduit, can be electro-galvanized at speeds up to 2000 pieces per hr. All operations are automatic, from the time the steel tubes are picked up at one end of the line until they emerge, tied in bundles, at the other.

In the process, the tubes are given two cleanings and rinses, are carried through the plating solution and a chromic acid solution, and their rinses and are carefully dried. Each length is printed with the Spang trade mark and the Underwriters Laboratories approval seal.

The equipment also is used in applying a second galvanizing coat to rigid steel conduit, which previously has been hot-dip galvanized and threaded. Because of the improved manufacturing process, this has been given a new trade name, Spang Blue Star conduit. Couplings and thread protectors are automatically attached to the rigid conduit before bundling.

A feature of the installation is that all rinse water is chemically treated so that it is pure when discharged to the sewer lines. Vents above the equipment carry off any fumes.

The successive stages in the electroplating process are: (1) immersion in an alkaline electro-cleaner; (2) rinse; (3) immersion in a special alkaline cleaner; (4) rinse; (5) immersion in the plating solution; (6) drip dry; (7) rinse in chlorinated water; (8) immersion in chromic acid; (9) chromic acid neutralizing rinse; (10) cold water rinse; (11) hot water rinse and (12) warm air drying.

Following its discharge from the drying oven, the rigid steel conduit goes through the automatic equipment that attaches the couplings and thread protectors. Both the electrical metallic tubing and the rigid steel conduit go through the printing equipment and the automatic bundling equipment.

An electrical current of more than 50,000 amp is circulated through the plating solution. Zinc anodes in baskets are used to deposit an increased amount of zinc coating on the threaded ends of the rigid conduit.

The chromic acid bath deposits a film of chromate over the galvanized coating, producing an iridescent finish that helps prevent white rust.

The conduit finishing dept. was the first to go into production in the new multi-million dollar combination pipe mill at National Supply's Ambridge plant. Other operations of the department include sawing the tubes to the uniform 10-ft conduit length, reaming and threading the rigid conduit.

When the new combination pipe mill goes into complete operation, scheduled for July, 1962, it will be equipped to make either continuous weld of electric resistance welded steel pipe and also to stretch-reduce seamless pipe to smaller sizes. To produce rigid steel conduit, some of the welded pipe will be routed through the automatic hot-dip galvanizing equipment, cut to conduit length, threaded and coupled and put through the electroplating line. ▲

Clark Controls efficiently direct movement of steel in this giant new heat treating furnace installed at United States Steel's Homestead, Pa., works.

Better traffic control for the Automation Highway

Some people believe that automation restricts flexibility. Not so with those whose production is governed by Clark electrical control equipment.

Take the steel industry's new Drever high-output plate heat treating furnaces. The Clark-engineered drive system for plate propulsion gives operators positive control of travel. Twenty-ton slabs move forward, backward, accelerate and decelerate on command. Speed-matching of rollers permits processing several plates at a time. Adjustable speed control makes exit possible with minimum heat loss.

Clark is proud to have been selected by Drever to take complete responsibility for the electrical drives and controls on these highly flexible, automated furnaces. We would like to work with you, too, in integrating power and control for your production highways. Just call the nearest Clark sales office, or write: 61A2

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Figure 1 — The second construction phase of the laboratory complex is nearing completion.

Bethlehem Steel Co. Dedicates Research Laboratories

DEDICATED to the constant search for continuing progress in steel technology, Bethlehem Steel Co.'s new Homer Research Laboratories now consolidates at one location the research activities which formerly were scattered in many locations throughout the company.

Since Bethlehem produces an unusually wide range of steel products, the activities of the laboratories cover many technological fields, including process metallurgy, chemical engineering, physical metallurgy, mechanical engineering, ceramics, physics, corrosion engineering, chemistry, mineralogy, electronics, mechanics, thermodynamics and nuclear studies.

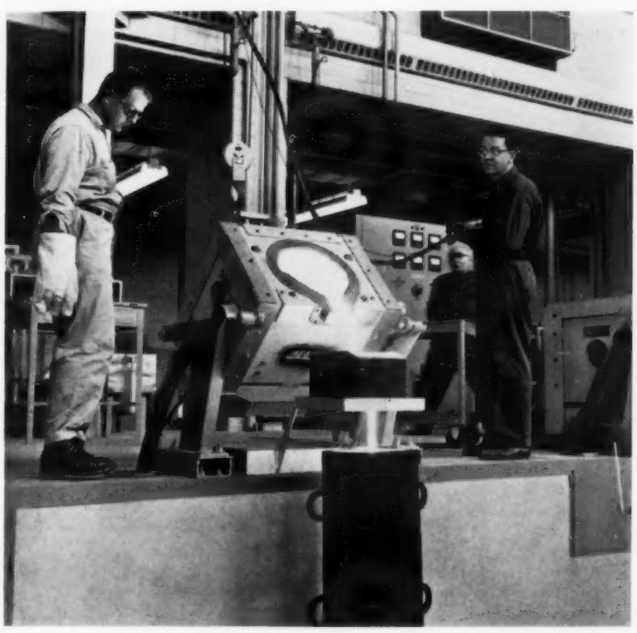
The unusual and the important equipment at the laboratories are listed:

A total of six complete spectrographic laboratories with prism and grating-type spectrographs offer photographic and direct-reading methods of detection; also, an installation for work in the vacuum ultraviolet region and an X-ray fluorescence apparatus.

The mechanical testing equipment includes a 100,000-lb universal testing machine, two 10,000-lb tensile machines, a 30-ton drawing press, an impact machine and a high-speed rotating beam fatigue machine.

Figure 2 — Disk pelletizing experiments are carried on to determine suitable processing of materials for the blast furnace burden.

Figure 3 — An experimental heat is poured from a 300-lb air induction furnace.



An X-ray diffractometer is used for identification of unknown compounds in crystalline material.

An electron microscope and auxiliary vacuum evaporation equipment allow magnifications up to 200,000 times in metallurgical investigation.

An electron diffraction unit determines the composition and structure of very thin surface films.

A 3-zone vertical tube furnace is used for producing various types of metal and oxide coatings and for studying oxidation.

An environmental test cabinet for the full range of programmed environmental conditions handles up to one tone of 24 x 24-in. sheet.

An X-ray diffraction and fluorescence unit and petrographic microscopes are available for the identification of mineral constituents of agglomerated ores, refractories and slags.

Four autoclave installations (protected by high-tensile strength steel plate) in a pressure laboratory are used for leaching experiments.

Extensive glassware apparatus is available for the fabrication of flexible plant counterpart stills used in the study of chemical piloting operations.

Infrared spectroscopy, an absorption spectroscopy method for "finger printing" organic materials for positive identification, is available.

The structures testing equipment include 300,000 and 60,000-lb universal testing machines, a 60,000-lb fatigue testing machine and a horizontal static and dynamic tension apparatus for testing "structures" rather than merely testing "samples of materials."

Extensive welding equipment with a full range of manual arc and gas welding equipment, flash welders, a spot welder and console-controlled submerged-arc units mounted on a ram-type fixture are used in research projects.

The complete heat treatment laboratory has box furnaces and auxiliary equipment covering the full heat-treatment temperature range for steel alloys.

The equipment in the process metallurgy pilot plant includes: a 3-ton arc furnace; 100, 300 and 650-lb air induction furnaces; a 500-lb vacuum induction furnace; a 10-kw ultrasonic unit for high-frequency vibration of steel ingots during solidification; hood and dust collector for the arc furnace; a drying oven; scales up to 10,000-lb capacity; a 15-ton overhead crane with a 3-ton hoist and a 750-lb forging hammer.

An open hearth model for the study of air and gas flow patterns through checkers, uptakes and hearth is an item of primary interest.

Even the best and most modern experimental equipment is of little value without the proper personnel. The over-all value of industrial research is dependent upon the potential of the people conducting the program. The present group of 450 research personnel is expected to double in size within five years.

Physical facilities and tools of research at the new laboratories have been planned and designed with great care. In addition, the project has been designed in such a way as to permit a 300-per cent expansion of physical facilities. ▲

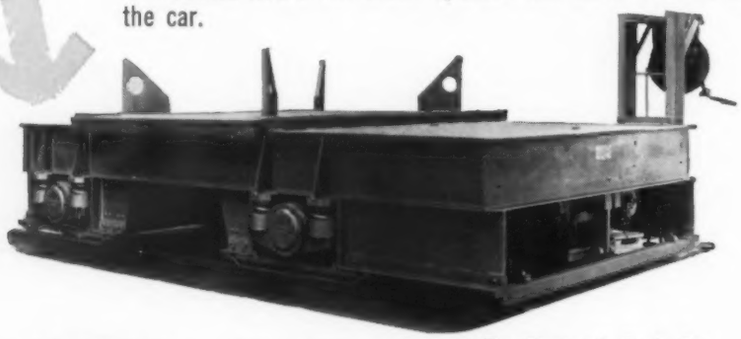
Tape Recording

Chart Recording

Atlas Builds Electronic Scales for -

Blast furnace scale cars, Coke weighing, Scrap bucket charging

This 60-ton scale car handles scrap buckets from the scrap yard to electric furnaces. For safety, the operator controls the car movement from a remote location. The electronic scale dial is mounted where the crane operator can watch it while loading the car.



60-Ton Electronic Scale Car

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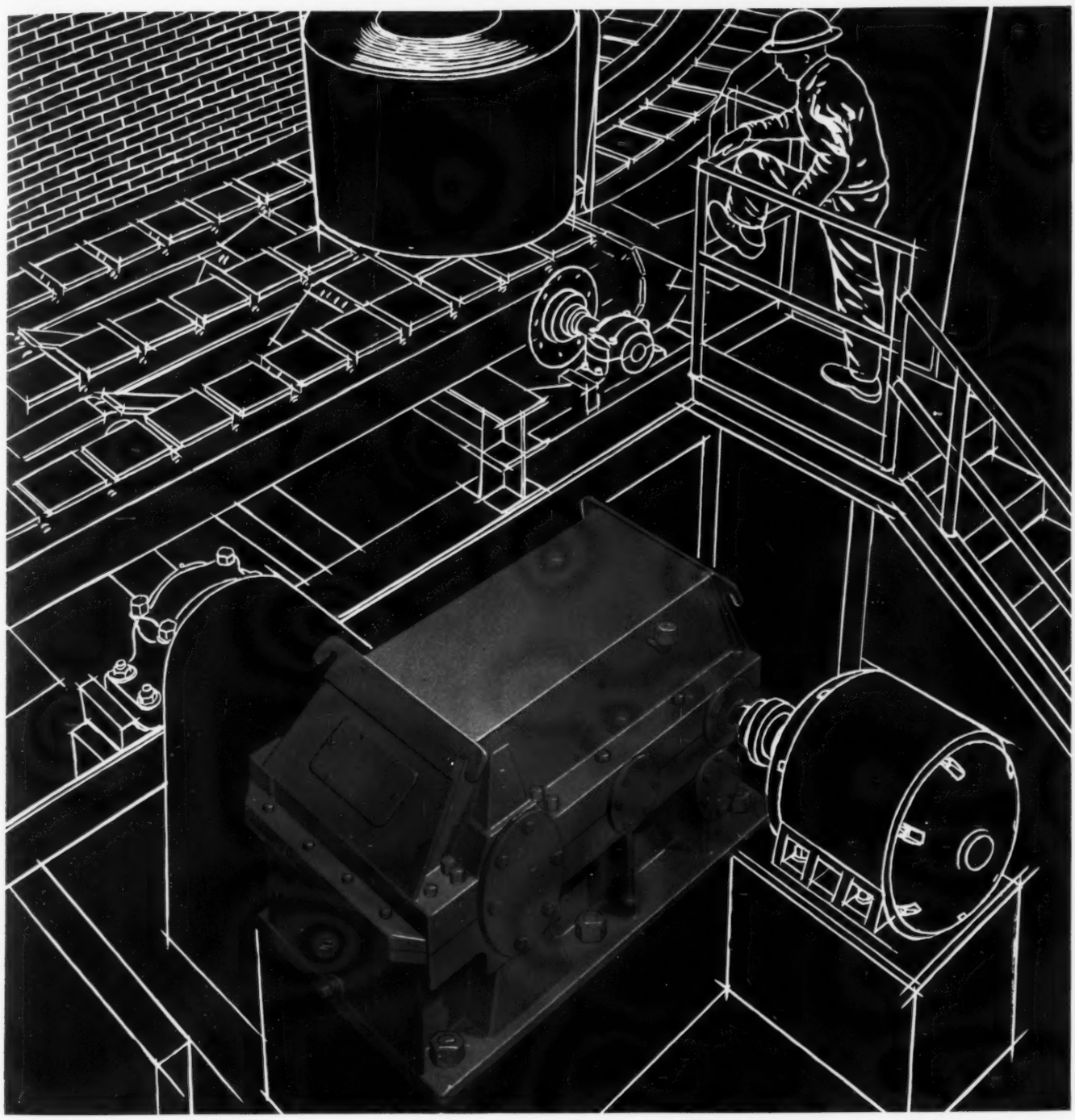

LINK-BELT PARALLEL SHAFT MILL DRIVES WITH NEW WELDED STEEL HOUSINGS

shrug off shock loads

Mill engineered Link-Belt parallel shaft drives are built for continuous duty under the most grueling conditions. They are ideal for applications involving heavy shock loads and temporary overloads. The rugged welded steel housings withstand severe external abuse and keep parts accurately and permanently aligned.

Herringbone or double helical gears are arranged in a "balanced" design that provides high-hp, high-ratio reduction. Other features include: positive splash lubrication, high-capacity spherical roller bearings and unique grease-lubricated seals.

Link-Belt offers 57 sizes . . . shafts projecting at two, three or four locations. Single, double and triple-reduction types, capacities to 2800 hp, ratios to 292:1.

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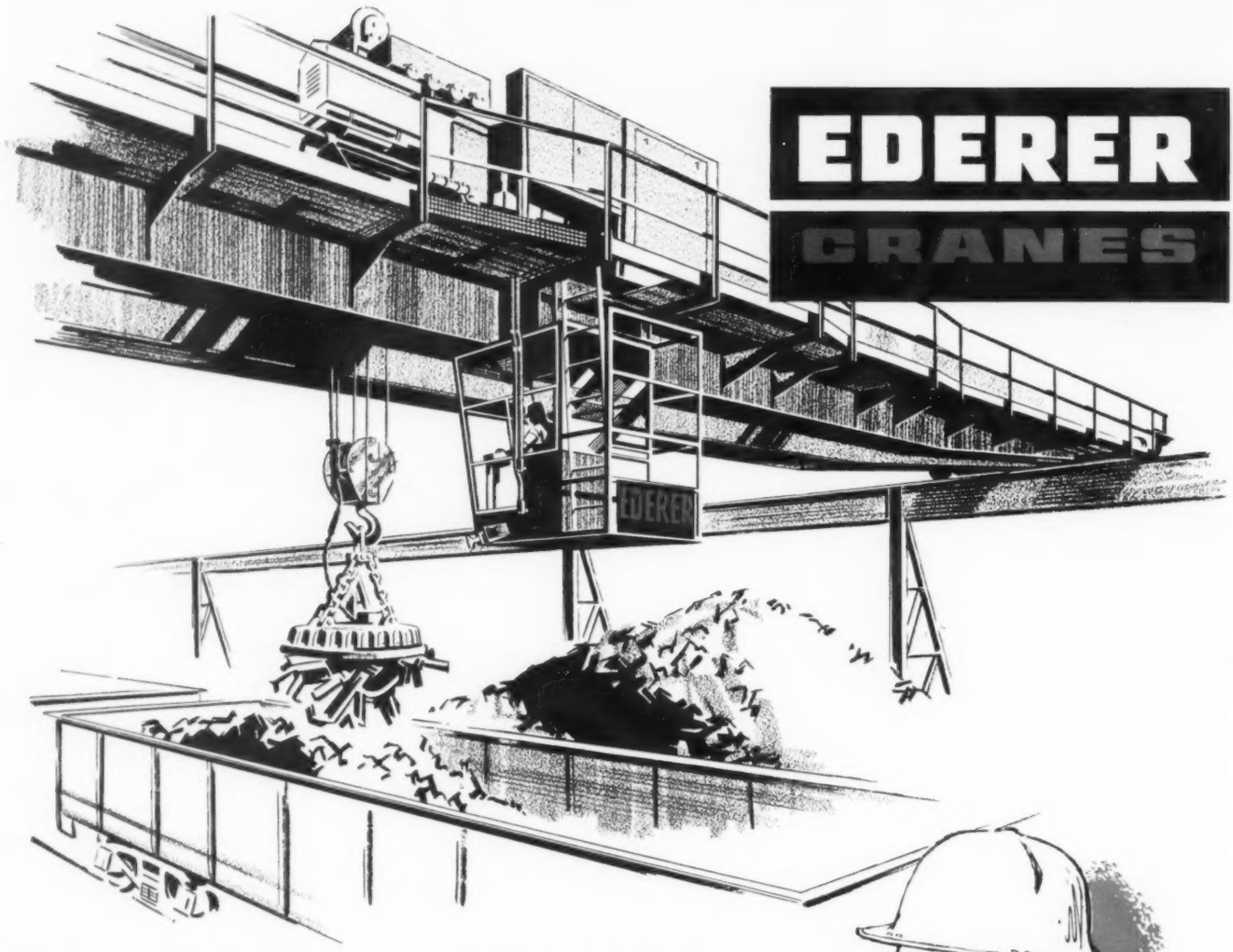

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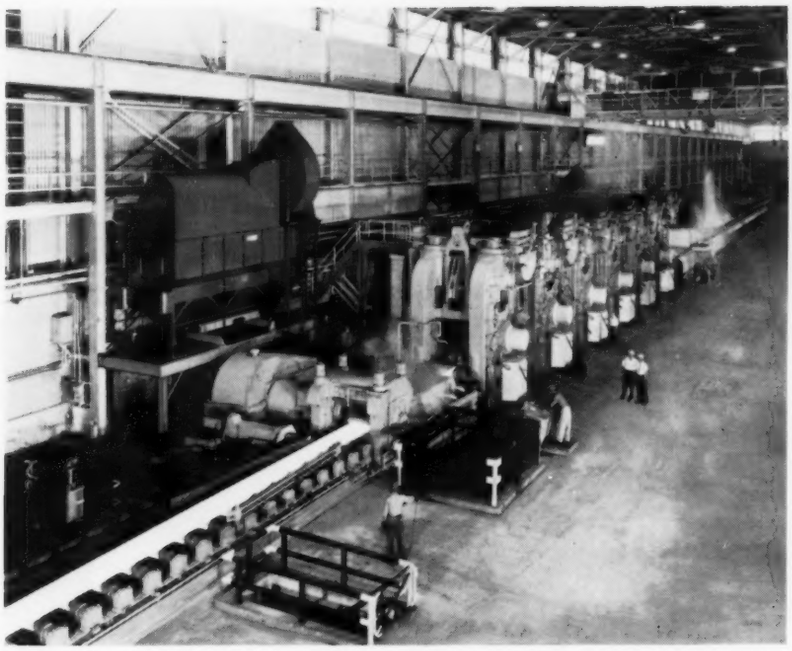


Republic's New Hot Strip Mill At Warren Now Operating

REPUBLIC Steel Corp.'s new hot strip mill at Warren, Ohio, which was dedicated on September 21, is a 56-in. semi-continuous unit designed to roll carbon, alloy, silicon and stainless sheets. It cost $55,000,000.

Basically, the mill consists of two 170-ton per hr triple-fired, recuperative heating furnaces, a vertical edger scalebreaker, a two-high rougher, a four-high reversing rougher with attached vertical edger, a finishing scalebreaker, six four-high finishing stands and two coilers.

Slabs may range 4½ to 10 in. in thickness, 14 to 52 in. in width and 14 to 28 ft long. Product may range as thin as 0.08 in. in thickness. Coils may range 14 to 52 in. in width and 36 to 73-in. outside diameter, and may weigh up to 50,000 lb (900 lb per in. of width). The mill is rated at 140,000 tons per month with two heating furances. Addition of a third furnace would raise this to about 200,000 tons per month.

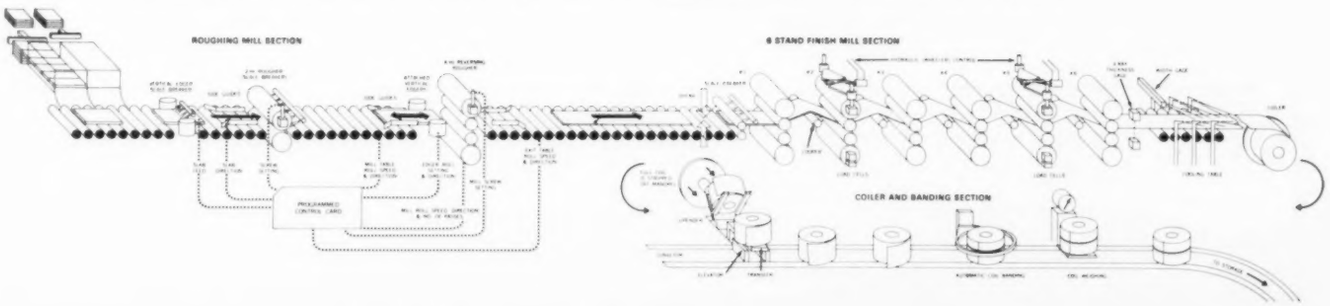
A total of 90,200 hp is required to operate all mill equipment. This stems from 766 motors ranging from five to 6000 hp. Main drive motors total 15,500 hp on the roughing end and 34,000 hp on the finishing end. Maximum delivery speed of the mill is 2400 fpm.

The roughing mill can be operated under automatic card control which governs slab feed; slab direction; vertical edger roll opening and direction; roll opening on the two-high rougher; mill table speed and direction; number of passes, roll opening and roll speed on the four-high rougher and its edger; and exit table speed and direction.

The finishing train operates under automatic gage control, with load cells to measure rolling force on each stand, hydraulic screw-down controls and hydraulic looper control. On signal from the load cells, the hydraulic screw-down controls on stands No. 2 and 5 give automatic gage correction in as little as 0.03 of a sec. The five hydraulic loopers provide constant tension and act as position indicators to regulate mill motor speeds. Constant records of strip thickness and width are provided by an X-ray gage and an infrared gage.

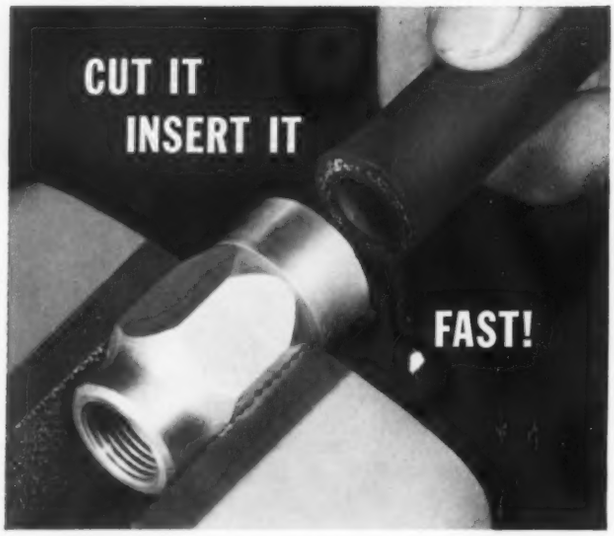
Hydraulically operated slides permit an entire coiler to be pulled out of line for mechanical and electrical servicing. Finished coils are automatically weighed by an electronic scale, where the coils are also automatically banded. ▲

Figure 1 — Schematic of new 56-in. hot strip mill at Republic's Warren, Ohio, steel plant.



Save Hose Replacement Dollars

Using PARKER Fittings with PARKER Hose to make Replacement Assemblies Faster

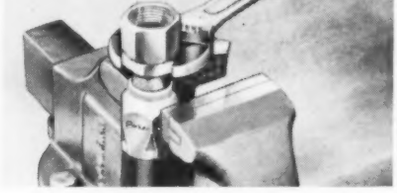


Installing Parker "Hoze-lok®" Fittings on Parker "No-Skive" Hose . . . NO SKIVING!

Installing ordinary fittings on ordinary rubber-covered hose . . . First, this messy skiving job.

Design of the "Hoze-lok" socket (left) makes the difference. The deep-tapped threads accept the **controlled thickness** rubber cover of Parker "No-Skive" Hose as they plow their way down to the wire braid of the hose. The rubber is displaced, not removed.

Just screw the hose in counter-clockwise, by hand. The rubber cover fills completely the space between each thread. It both protects and cushions the wire braid, eliminating a major cause of hose failure. A little Parker "Threadlube" is needed here.



The nipple, which is also the hose end fitting, screws in last, clockwise, in the usual way. You are now ready to make up the other end of your Parker No-Skive Hose Assembly. This method is not only faster; it gives you a better assembly. See next page.

You can install a Parker "Hoze-lok" Fitting on small-diameter Parker "No-Skive" Hose in 60 seconds. On 3/4" Parker hose, it takes 2 minutes or less. On very large sizes, allow 5 minutes per fitting. Hose replacement time is reduced to minutes the Parker No-Skive Way!

. *the* Parker No-Skive Way

Why Parker No-Skive Hose Assemblies Last Longer

BETTER PROTECTION FOR THE HOSE AT ITS POINT OF GREATEST STRESS

Most hose failures result from flexing. Ordinary hose, skived to the bare wire at the critical point where the first thread of the hose fitting bears directly on the wire braid, fails right there. As our picture shows, the leading thread of Parker "Hoze-lok" Fittings cannot reach the wire. The cushioning effect of the compressed rubber between the threads reduces the stress concentration at this point. Gripping by direct contact between the deep-tapped "Hoze-lok" threads and the wire braid occurs well within the fitting, where no flexing occurs.

Actual tests prove the effectiveness of this better design feature. Parker "Hoze-lok" assemblies on Parker "No-Skive" Hose rarely fail at the fitting, even when stressed to the burst point.

HOW PARKER DEVELOPED A BETTER HOSE TO MAKE THESE SAVINGS POSSIBLE

Parker "Hoze-lok" Fittings can be used with any hose, but you still have to skive ordinary rubber-covered hose, even with "Hoze-lok" fittings. Parker "No-Skive" Hose, however, is made to rigid specifications that limit and *control* the thickness of the cover to the exact amount of rubber that the corresponding size of "Hoze-lok" fitting will accept, when attached without skiving.

In all other characteristics, from the inner liner to the OD of the outermost wire braid, Parker "No-Skive" Hose conforms to S.A.E. specifications. In addition, because only a better grade of rubber compound can be extruded to Parker's exacting *controlled thickness* specification, the increased resistance to abrasion of the Parker "No-Skive" rubber cover results in a better hose.

PARKER HANNIFIN CORPORATION

Parker FITTINGS AND HOSE DIVISION

17325 Euclid Avenue • Cleveland 12, Ohio

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

ARRANGE NOW FOR A PARKER NO-SKIVE DEMONSTRATION IN YOUR OWN PLANT OR OFFICE

Gentlemen: We would like to see the Parker No-Skive Way to make up replacement hose assemblies demonstrated, without any obligation on our part, of course.

Please ask your salesman or nearest "Hoze-lok" distributor to get in touch with me:

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Title, Department or Division _____

Company_____

Address_____

City_____ Zone_____ State_____

We use hose for_____

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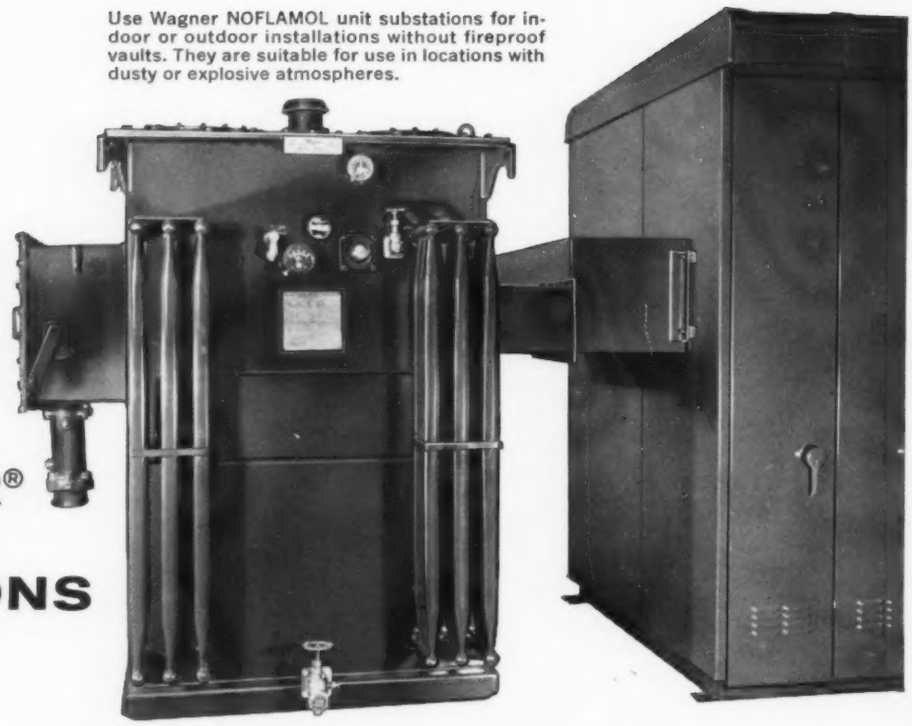
Use Wagner NOFLAMOL unit substations for indoor or outdoor installations without fireproof vaults. They are suitable for use in locations with dusty or explosive atmospheres.



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WAGNER® UNIT SUBSTATIONS

Get complete, coordinated load centers that give you continuous, dependable power now... have plenty of capacity and flexibility for growth

An uninterrupted flow of power... that's the important thing in your buildings, be they sprawling, single-story factories or high-rise offices. You can't afford to be handicapped by substations that are unable to meet current or expanding needs... and you won't be, if those substations are Wagner® unit substations.

Designed to improve voltage regulation, and built to be troublefree, they are coordinated load centers that provide the flexibility needed to meet future load requirements. They consist of a proved Wagner transformer, universally acceptable interrupting devices, highly reliable air break switchgear, and metering equipment combined in perfect power packages. To simplify installation, they are factory tested and shipped completely assembled, ready for service. They economically deliver utilization voltage with shorter, less expensive conductor runs... lower maintenance costs with modern, protective enclosures... safeguard your valuable equipment with adequate interrupting capacity. And your substation investment is protected because one manufacturer has responsibility for all component parts.

Wagner unit substations are built with transformers rated 112½ through 2000 kva, 3-phase, 60 cycle ratings with high voltages of 2400, 4160, 4800, 6900, 7200, 12000, 13200, or 13800 volts and low voltages of 240, 208Y/120, 480 or 480Y/277 volts.

Four types per NEMA standards are available: sealed dry-type; ventilated dry-type; oil-filled; and Noflamol (non-inflammable liquid-filled).

Wagner Electric Corporation

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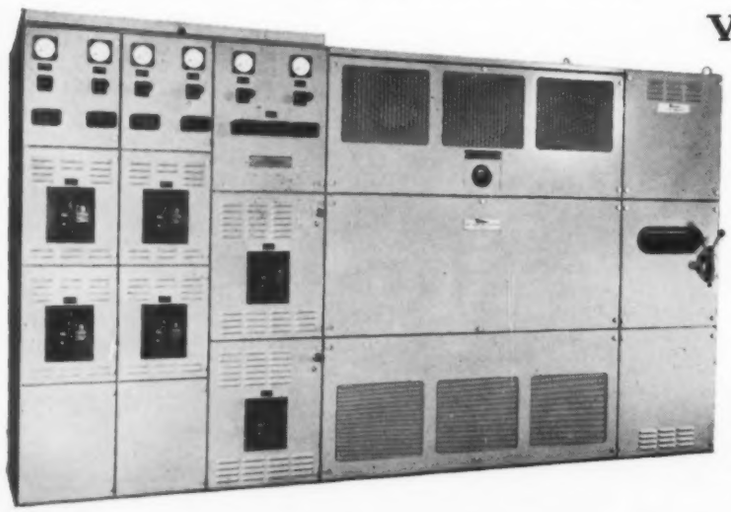

Your Wagner Sales Engineer

will be glad to help you plan your power distribution system. Get complete information on Wagner unit substations from him, or write us for Bulletin TU-152.

Use Wagner VENTILATED DRY-TYPE unit substations indoors. They perform efficiently in any reasonably dry, dust-free, well-ventilated location. Lightweight makes them ideal for use in multi-story buildings.

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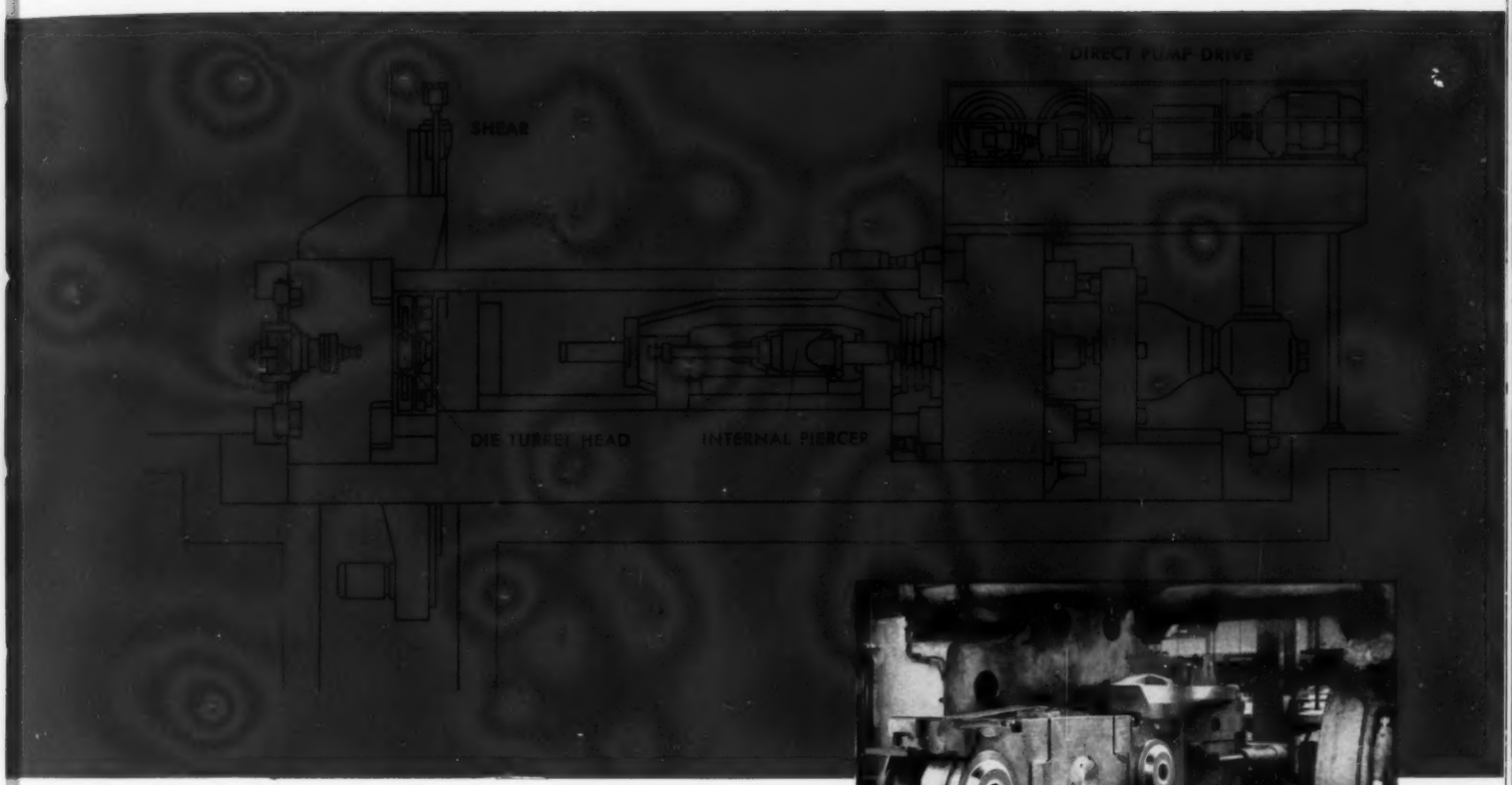
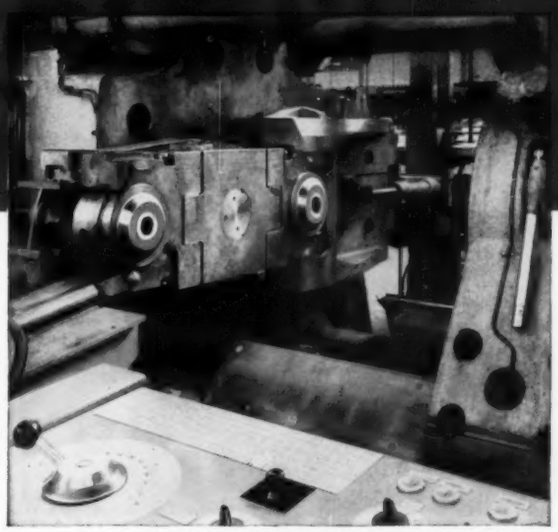
SELF CONTAINED EXTRUSION PRESS



Automatic rod and tube self contained extrusion press



Die turret head of a new SCHLOEMANN press in Europe

This press is designed for high productivity, gauge accuracy and minimum cycle time. SCHLOEMANN know-how based on many years of experience is incorporated in the new press. Such additional features as "static" controls for press and auxiliaries render electrics simpler and more effective. This together with the direct pump drive allows for efficient production at high or low press speeds.

To date thirty-five of these new presses up to 5500 tons capacity have been built or are on order. Consult us on further details of the new U.S. built SCHLOEMANN press.

- Multiple die holder turret head
- Severing in front or behind die
- Internal piercer
- Fully automatic working cycle

FELLER ENGINEERING COMPANY 1161 Empire Building, Pittsburgh 22, Pa.

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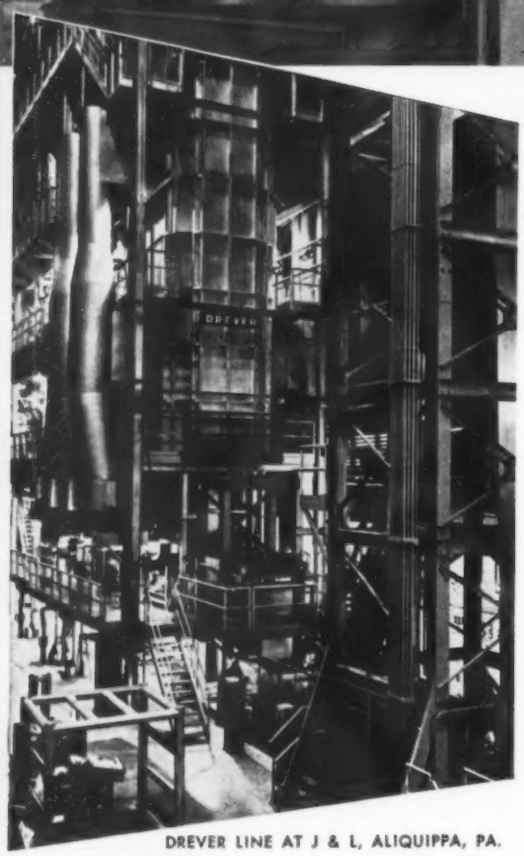

DREVER LINE AT J & L, ALIQUIPPA, PA.

NOT "INDIAN TALK"— JUST A CRYPTIC DESCRIPTION OF THE DREVER "CONVECOOL" SYSTEM FOR ANNEALING LINES

In an uncomplicated design of Plenums (1), Slotted Blast Vents (2), Side Suction Chambers and Ducts (3), (4); with a minimum of Heat Exchangers (5), and Blowers (6); the "Convecool" Convection Cooling System used in Drever Strip Annealing Lines embodies extraordinary engineering ingenuity.

MAXIMUM COOLING EFFICIENCY—MAXIMUM MAINTENANCE ACCESSIBILITY

"Convecool" provides greater cooling atmosphere contact with the strip in a balanced design that can only fail safe without product spoilage or equipment damage. In contrast with complex water systems or multiple motor-blower-heat exchanger arrangements, the "Convecool" unit utilizes a modicum of moving parts in a simplified design that allows immediate, complete accessibility for maintenance or quick repair. Now in operation at the Aliquippa Works of Jones & Laughlin Steel Corp., the "Convecool" section of the Drever Annealing Line can handle strip up to 2000 fpm. At 1000 fpm strip is cooled from 900°F to 150°F in 43 seconds.

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Achieving a desired effect with such simplicity of design and operation takes advanced engineering. Just such engineering is necessary to meet today's demand for higher production with more exacting quality standards at lower operating cost. Our engineers are available for consultation concerning your requirements. Write or phone us. Drever Company, Bethayres, Pa. Phone: Wilson 7-3400.

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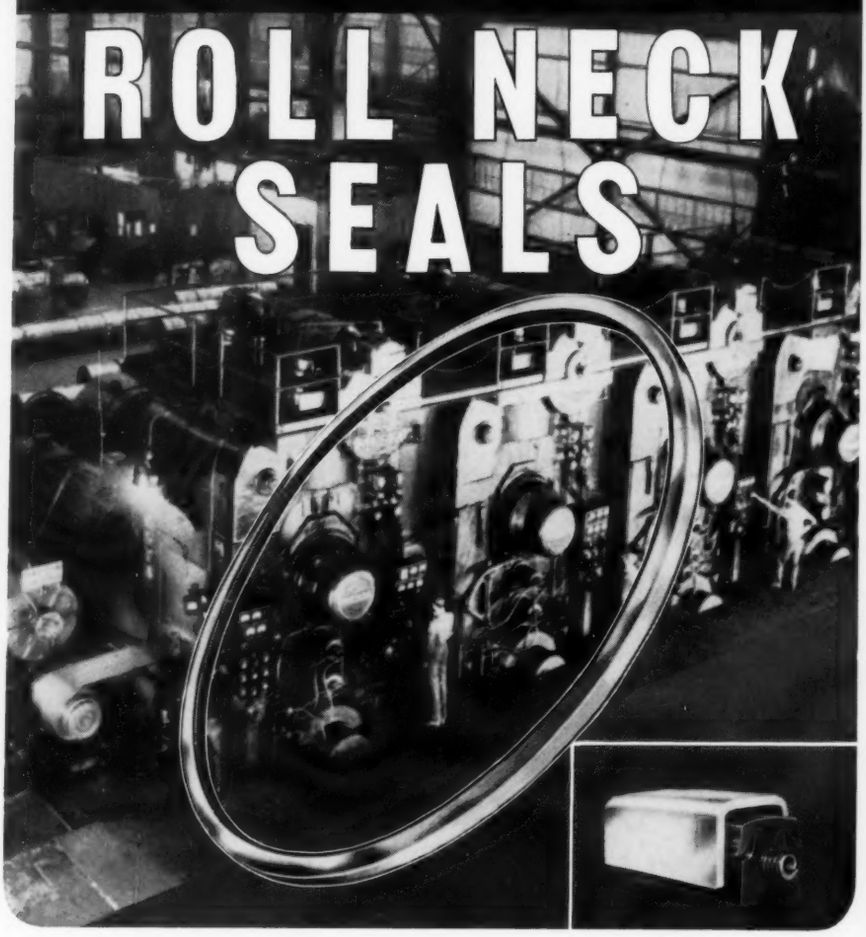
Effectively seal in lubrication

Seal out water, scale, debris

ROLL NECK SEALS



For both work and back up rolls

Syntron Roll Neck Seals are designed to do all the sealing of roll neck bearings — keep clean lubricant in — dirt, scale, water out.

This unique and simply designed seal offers many money saving features to the cost conscious.

Syntron Roll Neck Seals are simple to install — will not score roll neck sleeves — frictional surfaces function within the seal — heat is easily dissipated to bearing chock — seals won't take a set when mill is stopped — seals are not spring loaded — load automatically and seal by fluid to be retained — flexible elements do not glaze, harden, chip, or crack. Roll Neck element or housing may be purchased separately.

Syntron Seals have on the job proof of long service life and low maintenance.

Insist on the most modern device conceived for your sealing problem. Syntron builds a seal for practically every size rotary shaft application.

Write now for complete literature on Syntron Seals.

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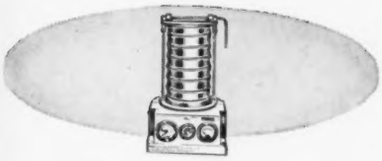
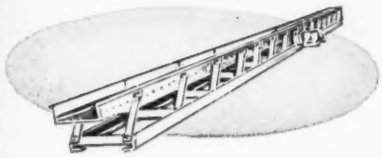
Other SYNTRON *equipment of proven dependable quality*

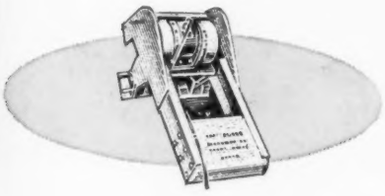


Test Sieve Shakers

Rectifier Power Units



Mechanical Vibrating Conveyors



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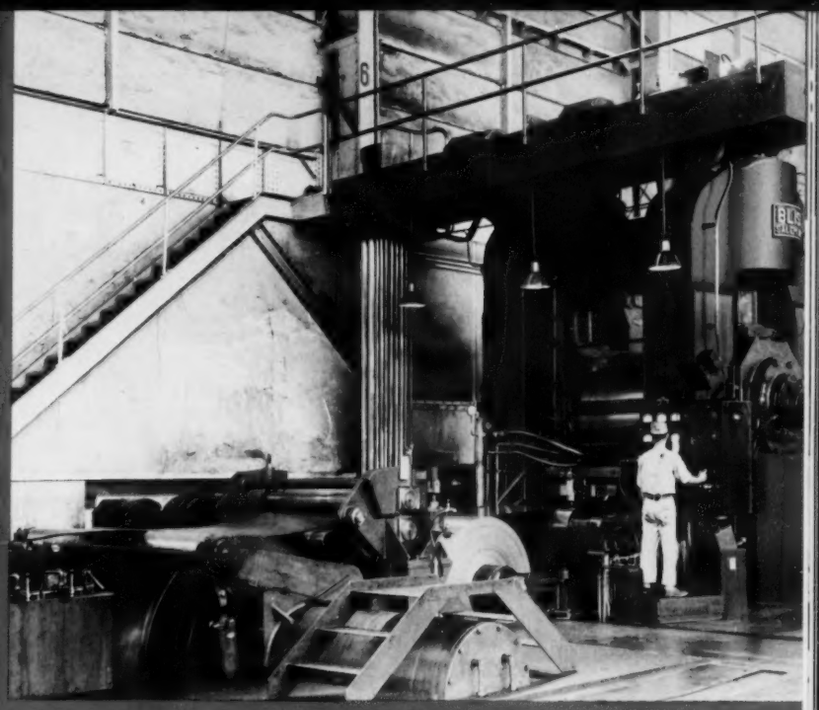

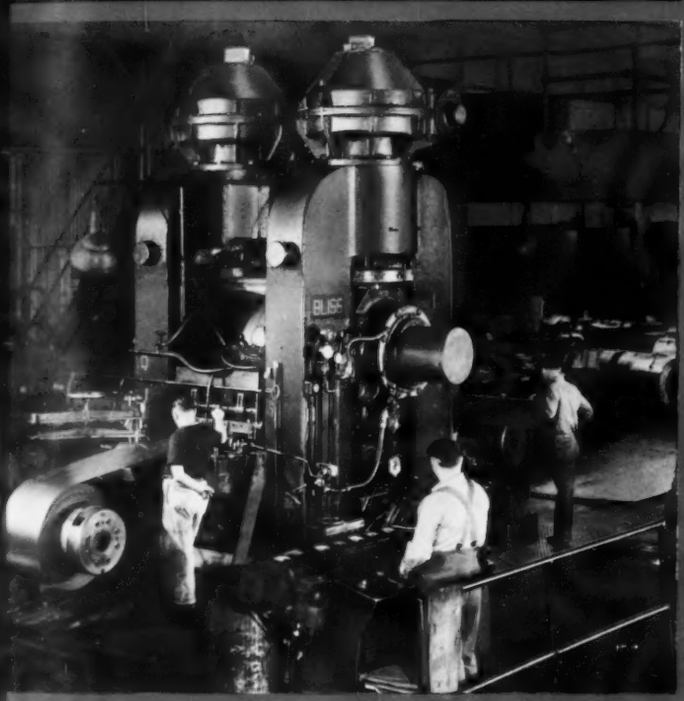

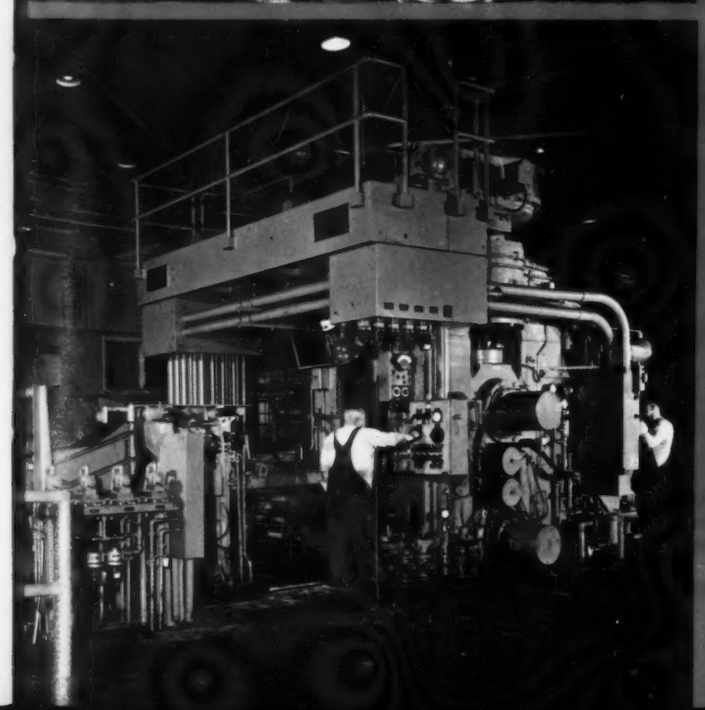

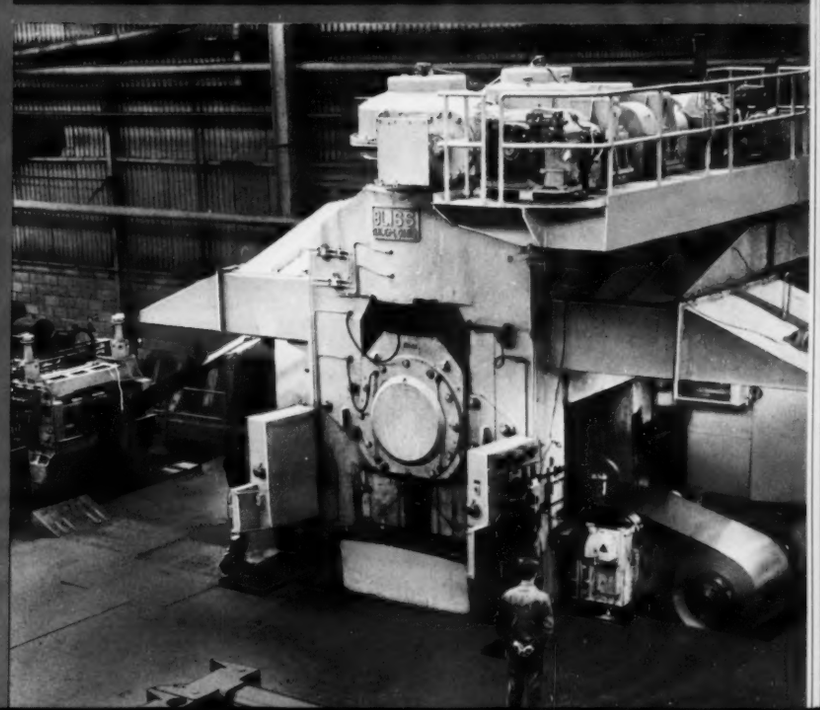

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MANUFACTURERS OF TOP QUALITY "SEMI-STEEL" SHOT AND GRIT, MALLEABLE AND CHILLED SHOT AND GRIT — AT COMPARABLE SAVINGS

Date-line Diary...

October 2

△ The Bureau of Mines reported that production of pig iron in the U. S. in July, 1961, totaled 5,597,352 net tons; U. S. production of steel ingots and castings in July, 1961, totaled 8,158,047 tons.

△ The American Iron Ore Assn. reports that U. S. shipments of iron ore down the Great Lakes in September, 1961, totaled 8,453,170 gross tons, compared with 7,877,142 tons in September, 1960.

October 4

△Jessop Steel reports it is developing a tentative program with Vummidiars Private, Ltd., Madras, India, to build a plant which would have an annual capacity of 7000 to 10,000 tons of finished alloy steel. The Indian government has issued a license to Vummidiars for the erection of the plant at a total outlay involving $5,000,000. Jessop, in addition to equity participation, would supply engineering and technical know-how in the plant's operation.

△ The Labor Dept. reported the number of jobless in mid-September totaled 4,085,000, down 457,000 from the August total; the seasonally adjusted rate of unemployment eased to 6.8 per cent, compared with 6.9 per cent in August.

△The Japan Iron & Steel Federation reports that production of pig iron in Japan in July, 1961, totaled 14,454,000 tons; ingot steel, 26,600,000 tons.

October 5

△ The Bureau of Mines reported that production of Pennsylvania anthracite in September, 1961, totaled 1,423,000 net tons, compared with 1,565,000 tons in August, 1961, and 1,580,000 tons in September, 1960.

△ AISI reported that steel mills shipped 6,139,418 tons of finished steel production in August, 1961, compared with 5,120,808 tons in July, 1961, and 5,071,953 tons in August, 1960.

October 6

△ The Aluminum Assn. reports that shipments of aluminum sheet and plate in August, 1961, totaled 130,547,000 lb, compared with 120,072,000 lb in July, 1961, and 114,784,000 lb in August, 1960. Shipments of aluminum foil in August, 1961, totaled 22,786,719 lb, compared with 17,777,952 lb in July, 1961, and 20,291,560 lb in August, 1960.

October 7

△ The AISI reports that production of steel for the week ending October 7, 1961, totaled 2,102,000 net tons (about 73.7 per cent of capacity) compared with 2,131,000 tons one week ago (74.8 per cent of capacity) and 1,558,000 tons one year ago. Index of production was 112.8.

△ R. H. Larry, administrative vice president, labor relations, United States Steel Corp., and David J. McDonald, president, USW jointly announced that a 1½¢ cost-of-living increase will be effective retroactive to October 1 for United States Steel basic steel employees represented by the union. The increase was established after determination of estimated insurance costs required by the contract to be offset against an increase in the cost-of-living adjustment.

October 9

△ The Census Bureau reported that U. S. imports in August, 1961, amounted to $1,259,000,000, after seasonal adjustment, a decline of eight per cent from the July total, but three per cent higher than August, 1960.

October 10

△ The AISI reports that the steel industry's payroll for hourly and salaried workers in August, 1961, totaled $336,819,552 compared with $307,047,803 in June, 1961, and $300,259,708 in August, 1960. Total employment in August numbered 545,293 compared with 538,383 in July, 1961, and 542,668 in August, 1960. Payroll cost per hr worked by hourly employees was $3.447 in August, 1961, compared with $3.520 in July, 1961, not including 50¢ an hr supplemental employee benefits. Average hours worked per week were 37.8 in August, 1961, compared with 33.2 in July, 1961.

△ The Bureau of Mines reports that U. S. consumption of scrap in August, 1961, totaled 4,977,000 gross tons, compared with 4,295,665 tons in July, 1961; pig iron consumption in August, 1961, totaled 5,167,000 gross tons, compared with 5,025,158 tons in July, 1961.

△ The Bureau of the Census reported that shipments of commercial steel forgings in August, 1961, totaled 98,488 tons, compared with 71,924 tons in July, 1961, and 88,294 tons in August, 1960. Bookings on August 31, 1961, totaled 279,280 tons, compared with 279,657 tons on July 31, 1961, and 299,000 tons on August 31, 1960.

October 11

△ The AISI reports that production of ingot and steel for castings in September, 1961, totaled 8,904,000 net tons, compared with 8,660,527 tons in August, 1961, and 6,458,421 tons in September, 1960. Production during the third quarter of 1961 totaled 25,656,485 tons, compared with 19,647,345 tons in the same quarter, 1960. Production for the first nine months of 1961 totaled 70,515,145 tons, compared with 80,401,440 tons in the first nine months of 1960.

△ Directors of The M. A. Hanna Co. approved a far-reaching plan of simplification of the ownership and management of the company's business interests. The plan, to be voted on by stockholders on October 31, proposes to dispose of the company's direct business activities and become one of the country's largest closed-end investment companies, with assets of approximately $500,000,000 of value, largely consisting of common stocks and cash items. Approval will be requested for the creation of a single class of common stock, to be exchanged on a four-for-one basis for the presently outstanding Class A and Class B common shares.

△ The Labor Dept. announced that nonfarm employment in mid-September totaled 53,920,000, up 509,000 over the mid-August level.

October 12

△ The Bureau of the Census reported that production of titanium mill products in August, 1961, totaled 960,647 lb, compared with 727,937 in July, 1961, and 963,908 lb in August, 1960.

△ Treasury Under Secretary Fowler, in a speech in

New York, outlined Treasury Dept. plans to stimulate capital spending: liberalized depreciation allowances for all industries where officials find technical progress is rapid, and a new request to Congress early in 1962 for tax credits to spur business investment in new equipment.

October 13

△ Woodward Iron stockholders approved an increase of 625,000 shares in authorized common, clearing the way for the acquisition of Lynchburg Foundry Co., Lynchburg, Va., and National Cement Co., Ragland, Ala.

△ U. S. Circuit Court Judge Austin Staley in Pittsburgh granted the AFL-CIO United Steelworkers of America a stay of a court order ruling illegal the method used by the union to nominate and elect international officers. The union is appealing the federal judge's finding that vote procedure violates Landrum-Griffin Act.

October 14

△ The AISI reports that production of steel for the week ending October 14, 1961, totaled 2,071,000 net tons (about 72.7 per cent of capacity) compared with 2,102,000 tons one week ago (73.7 per cent of capacity) and 1,579,000 tons one year ago. Index of production was 111.2.

October 16

△ Jessop Steel Co.'s warehousing division abolished a 7.5 per cent discount on stainless steel sheet prices, mostly sold through warehouses.

October 17

△ The Bureau of the Census reports that shipments of iron and steel castings for July, 1961, totaled 923,152 net tons compared with 1,203,569 tons in June, 1961, and 942,731 tons in July, 1960.

△ The Bureau of the Census reports that net shipments of aluminum pig and ingot in August, 1961, totaled 123,383,000 lb, compared with 110,691,000 in July, 1961, and 161,106,000 lb in August, 1960; net shipments of aluminum mill products in August, 1961, totaled 302,093,000 lb, compared with 263,160,000 lb in July, 1961, and 261,423,000 lb in August, 1960. Net shipments of magnesium mill products in August, 1961, totaled 2,320,000 lb, compared with 1,743,000 lb in July, 1961, and 1,835,000 lb in August, 1960.

October 18

△ The Census Bureau said work begun on private new homes in September, 1961, was at a seasonally adjusted annual rate of 1,360,000 units, three per cent over the August pace, and 25 per cent over the September, 1960, rate.

△ The Commerce Dept. reported that income receipts of individuals in September, 1961, ran at a seasonally adjusted annual rate of $420,200,000,000, up $800,000,000 from the August, 1961, rate. Factory payrolls in September, 1961, were $400,000,000 below the August rate.

△ Can Manufacturers Institute, Inc., reports that can makers consumed 3,318,406 tons in the first eight months of 1961; shipments of aluminum cans totaled 21,198 tons in the same period.

△ The Commerce Dept. reported that seasonally adjusted new orders received by durable goods producers in September, 1961, amounted to $15,700,000,000, one per cent greater than the August, 1961, total and seven per cent higher than the September, 1960, total.

△ The ARCI reported that deliveries of new freight cars in September, 1961, totaled 2700 compared with 2428 in August, 1961, and 4300 in September, 1960. Orders in September, 1961, totaled 3143, compared with 1474 in August, 1961, and 2156 in September, 1960. Backlog of cars on order as of October 1, 1961, totaled 10,133, compared with 9690 on September 1, 1961, and 21,662 on October 1, 1960.

October 20

△ Federal Reserve Bank of New York reported that U. S. gold stocks fell by $48,000,000 in the week ended October 18. The Treasury's bullion holdings amount to $17,303,000,000, down $464,000,000 since January 1, 1961.

△ In September, 1961, Great Lakes iron ore tonnage totaled 10,109,362 tons, compared with 9,364,566 tons in September, 1960. Shipments for the season at the end of September, totaled 48,287,994 tons, compared with 67,962,096 tons in the same period of 1960.

October 21

△ The AISI reported that steel production for the week ending October 21, 1961, totaled 2,042,000 net tons (about 71.7 per cent of capacity) compared with 2,071,000 tons one week ago (72.7 per cent of capacity) and 1,579,000 tons one year ago. Index of production was 109.6.

October 23

△ The Aluminum Assn. reported that shipments of primary aluminum production in the U. S. in September, 1961, totaled 159,572 short tons, compared with 167,040 tons in August, 1961, and 162,882 tons in September, 1960.

△ The AISI reports that production of stainless steel in September, 1961, totaled 117,139 net tons, compared with 106,884 tons in August, 1961, and 74,096 tons in September, 1960. Production of stainless steel in the first nine months of 1961 totaled 824,999 net tons.

October 24

△ The Supreme Court refused to consider a union challenge to the power of state courts to hold labor leaders personally responsible for preventing strike violence. The High Court let stand the contempt-of-court convictions of two Cleveland union officials who had been ordered during a strike to "supervise and be responsible" for maintaining peace on the picket lines.

October 25

△ Westinghouse Electric Corp. reports for the quarter ending September 30, net sales totaling $467,131,000, net earnings of $5,451,000, equal to 14¢ per share, compared with net sales totaling $503,389,000, net earnings of $20,226,000, equal to 57¢ a share for the third quarter of 1960. For the first nine months of 1961, net sales totaling $1,387,512,000, net income of $25,012,000, equal to 67¢ a share, compared with net sales totaling $1,457,233,000, net income of $60,680,000, equal to $1.71 per share for the first nine months, 1960.

October 26

△ The Labor Dept. reported that consumer prices rose to 128.3 per cent of the 1947–49 average in September, 1961, up 0.3 from the August, 1961, index.

△ The AISC reported that bookings of fabricated structural steel in September, 1961, totaled 408,000 tons, compared with 384,981 tons in August, 1961, and 290,735 tons in September, 1960. Shipments in September, 1961, totaled 326,164 tons, compared with 359,467 tons in August, 1961, and 363,907 tons in September, 1960. Backlog as of September 30, 1961, was 2,729,313 tons.

△ The National Machine Tool Builders Assn. reports

STEEL COMPANIES QUARTERLY FINANCIAL REPORTS—JULY 1, 1961 TO SEPTEMBER 30, 1961

	Period	1961 Net Sales	1961 Net Profits	1961 Earnings Per Share	1960 Net Sales	1960 Net Profits	1960 Earnings Per Share
Acme Steel Co.	3rd quar.	$ 35,528,652	$ 510,193	$ 0.18	$ 29,810,603	$ (338,501)	$(0.12)
	9 mo.	100,982,799	563,801	0.20	112,436,722	2,073,977	0.75
Alan Wood Steel Co.	3rd quar.	13,131,000	(417,000)*	(0.69)	11,394,000	(82,000)	(0.21)
	9 mo.	40,771,000	(491,000)	(0.97)	48,363,000	1,123,000	1.35
Allegheny Ludlum Steel Corp.	3rd quar.	58,420,993	2,486,603	0.64	50,282,170	647,902	0.17
	9 mo.	173,463,233	6,779,723	1.74	185,680,731	6,180,486	1.59
Armco Steel Corp.	3rd quar.	237,512,721	14,513,437	0.98	213,474,758	11,693,836	0.79
	9 mo.	651,457,140	37,689,605	2.55	734,656,139	53,427,055	3.61
Atlas Steels, Ltd.	3rd quar.	13,543,000	435,000	...	...	547,100	0.50
	9 mo.	41,362,000	2,091,000	...	...	2,247,800	2.06
Bethlehem Steel Co.	3rd quar.	521,994,589	33,943,023	0.71	502,981,428	12,436,106	0.24
	9 mo.	1,471,731,830	67,910,900	1.38	1,727,833,816	93,979,141	1.96
Carpenter Steel Co.	3rd quar.	17,394,985	915,460	0.48	15,281,606	687,835	0.36
The Colorado Fuel and Iron Corp.	3rd quar.	...	710,432	0.16	...	(5,615,161)	(1.47)
	9 mo.	...	1,078,017	0.20	...	(3,200,729)	(0.91)
Copperweld Steel Co.	3rd quar.	24,514,239	109,252	0.09	22,150,312	(40,443)	...
	9 mo.	75,507,000	510,035	0.43	91,094,156	2,213,074	1.88
Crucible Steel Co. of America	3rd quar.	48,348,000	532,000	0.10	42,047,000	(1,826,000)	(0.51)
	9 mo.	137,056,000	(963,000)	(0.35)	166,715,000	1,208,000	0.21
Detroit Steel Corp.	3rd quar.	21,009,846	618,893	0.15	16,914,320	100,533	0.02
	9 mo.	57,274,704	918,811	0.23	72,718,356	4,307,998	1.08
Eastern Stainless Steel Corp.	3rd quar.	14,182,878	352,473	0.25	12,833,033	87,810	0.06
	9 mo.	45,412,434	1,555,182	1.08	47,631,924	1,313,476	0.91
Edgewater Steel Co.	9 mo.	11,284,323	372,958	1.99	11,711,392	359,814	1.92
Granite City Steel Co.	3rd quar.	34,750,817	1,939,125	0.45	28,833,364	1,783,858	0.41
	9 mo.	101,175,441	6,476,930	1.50	110,322,405	9,428,409	2.18
Inland Steel Co.	3rd quar.	187,831,291	14,441,290	0.81	166,661,366	5,135,369	0.28
	9 mo.	539,116,696	36,190,870	2.04	598,751,328	38,202,872	2.17
Interlake Iron Corp.	3rd quar.	...	1,087,841	0.49	...	515,502	0.23
	9 mo.	60,552,332	2,513,246	1.12	72,117,486	3,982,642	1.77
Jones & Laughlin Steel Corp.	3rd quar.	194,877,000	10,102,000	1.24	164,196,000	3,483,000	0.40
	9 mo.	541,382,000	21,929,000	2.65	625,784,000	29,619,000	3.63
Keystone Steel & Wire Co.	2nd quar.	27,167,370	1,594,980	0.85	22,580,099	696,218	0.37
Kaiser Steel Corp.	3rd quar.	70,480,876	7,679,572	2.09	46,207,920	(5,802,364)	(2.02)
	9 mo.	202,428,189	12,885,817	3.19	164,869,872	(1,072,560)	(0.42)
Lone Star Steel Co.	3rd quar.	23,622,548	1,854,089	0.47	14,977,451	303,971	0.08
	9 mo.	54,777,100	3,135,009	0.80	46,620,163	3,912,602	1.00
Lukens Steel Co.	36 wks.**	69,517,269	2,564,050	2.69	74,866,583	3,325,768	3.49
McLouth Steel Corp.	3rd quar.	46,430,691	2,142,572	0.61	49,911,787	3,445,658	0.94
	9 mo.	137,521,121	9,310,023	2.57	167,202,987	13,120,965	3.58
National Steel Corp.	3rd quar.	175,495,147	7,009,951	0.92	163,457,628	8,061,074	1.06
	9 mo.	479,500,944	23,174,117	3.04	557,706,440	35,362,435	4.67
Phoenix Steel Corp.	3rd quar.	10,350,000	(1,538,000)	(1.42)	6,640,000	(568,000)	(0.52)
	9 mo.	28,772,000	(3,717,000)	(3.43)	31,480,000	(727,000)	(0.67)
Pittsburgh Steel Co.	3rd quar.	34,726,644	255,634	...	26,942,897	(671,040)	...
	9 mo.	93,151,040	(1,199,607)	...	114,796,371	1,734,154	0.47
Republic Steel Corp.	3rd quar.	270,565,260	12,702,513	0.81	218,779,420	7,310,271	0.47
	9 mo.	727,046,812	33,956,391	2.16	862,213,739	48,718,754	3.10
Sharon Steel Corp.	3rd quar.	28,205,235	643,494	0.58	22,223,124	(840,342)	...
	9 mo.	74,268,814	381,855	0.34	94,618,539	1,114,514	1.01
Steel Co. of Canada, Ltd.	3rd quar.	78,269,241	8,348,814	1.65	64,556,950	3,754,127	0.86
	9 mo.	220,779,405	20,223,562	4.00	220,786,175	17,630,472	4.06
United States Steel Corp.	3rd quar.	861,320,608	51,757,122	0.84	785,249,769	52,415,599	0.85
	9 mo.	2,439,153,155	142,761,263	2.29	2,975,198,278	245,887,840	4.20
Universal Cyclops Steel Corp.	3rd quar.	27,293,366	841,750	0.43	23,821,396	537,428	0.28
	9 mo.	82,567,964	2,942,190	1.52	88,382,816	3,658,254	1.89
Vanadium-Alloys Steel Corp.	3rd quar.	5,699,765	208,653	0.33	5,531,446	203,163	0.32
Washington Steel Co.	3rd quar.	...	240,618	0.37	...	351,035	0.53
	Year	...	943,336	1.43	...	2,141,535	3.30
Wheeling Steel Corp.	3rd quar.	57,472,000	2,050,000	0.78	50,622,000	558,000	0.07
	9 mo.	157,846,000	3,767,000	1.20	188,400,000	8,714,000	3.54
Woodward Iron Corp.	9 mo.	...	3,574,046	1.39	...	3,999,335	1.56
Youngstown Sheet and Tube Co.	3rd quar.	143,894,538	5,146,532	1.47	121,686,767	2,676,626	0.77
	9 mo.	408,581,113	15,989,802	4.58	472,090,402	21,565,636	6.19

* Items in parentheses are losses. ** Ended Sept. 9, 1961.

net new orders of cutting and forming-type machine tools in September, 1961, amounted to $67,-300,000 compared with $54,900,000 in August, 1961. Shipments in September, 1961, totaled $52,-100,000 compared with $47,000,000 in August, 1961.

October 27

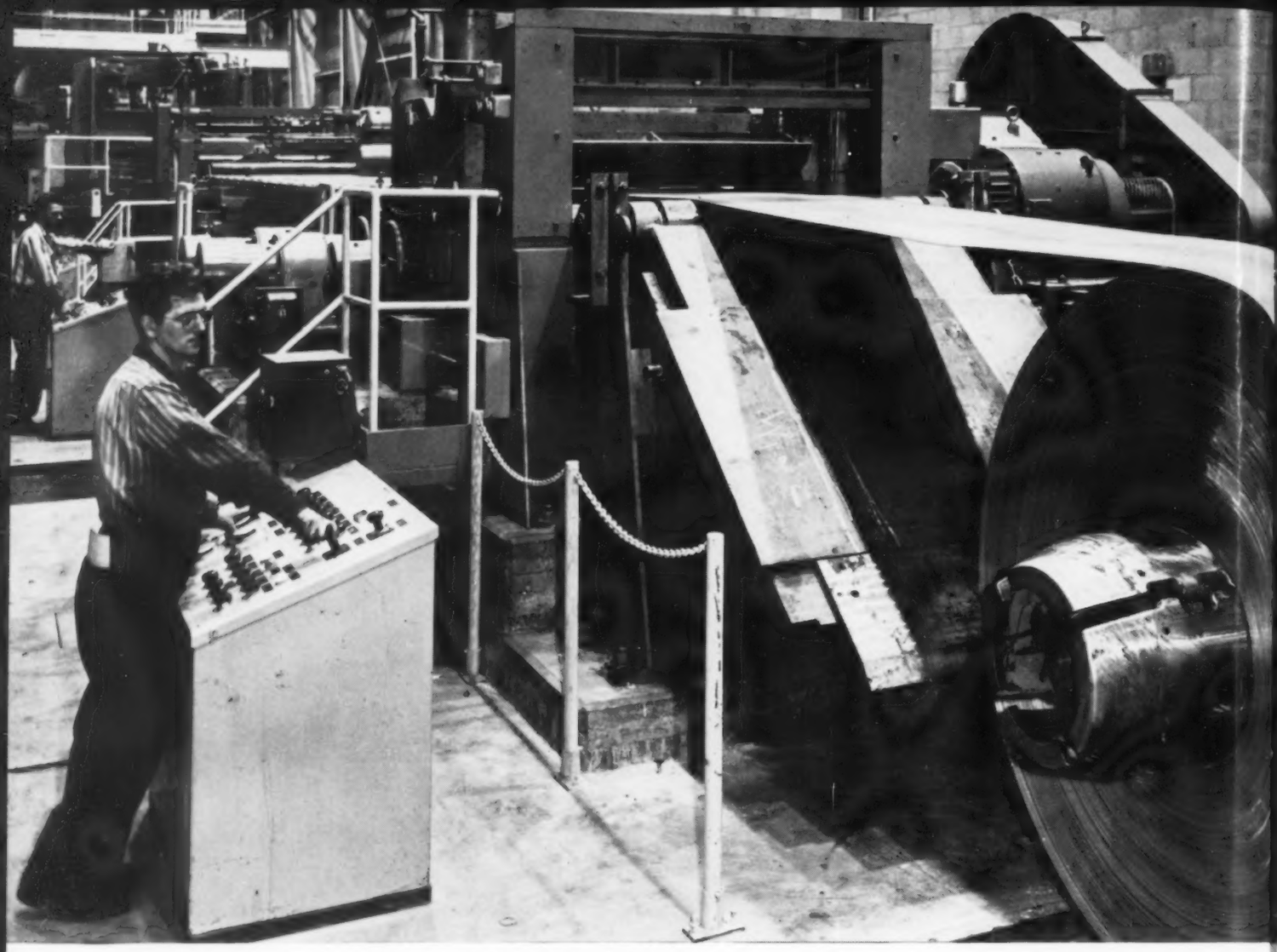
△ F. W. Dodge Corp. reported that total construction contracts in September, 1961, amounted to $3,004,-033,000, compared with $3,118,775,000 in September, 1960. Index (1947 to 1949 = 100) in September, 1961, was 261, compared with 293 in August, 1961, and 271 in September, 1960.

October 28

△ The AISI reported that steel production for the week ending October 28, 1961, totaled 2,057,000 net tons (about 72.2 per cent of capacity) compared with 2,042,000 tons one week ago (71.7 per cent of capacity) and 1,545,000 tons one year ago. Index of production was 110.4.

October 31

△ Carpenter Steel Co. stockholders approved an increase in the company's authorized capital stock to 5,000,000 shares.



Feeding in strip at the entry reel of a galvanizing line in Hamilton, Ontario.

SINGLE RESPONSIBILITY FOR DRIVE SYSTEM DESIGN PAYS OFF FOR CANADIAN MILL

The motors, controls, regulators and sensing devices which drive this continuous galvanizing line were integrated to produce a precise performance by one totally responsible source . . . Reliance Systems Engineering.

The drive system was designed to utilize sectional generators and control, thus achieving more flexibility to handle a broader range of products. Any or all units of the line consequently can be changed to meet new production demands. Positive speed sychronization between sections is achieved with Reliance transistorized VSRR magnetic amplifier regulators.

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Precise tension and tracking of the strip was quickly created and preserved throughout all 32 sections of the line . . . and uniform, high quality strip was produced. Reliance willingly accepted *total responsibility* for the planning and engineering of this processing line drive at the request of the mill . . . with logical and practical results.

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A-1687

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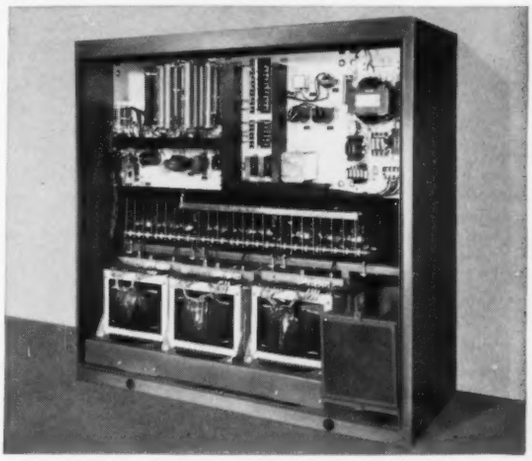

RELIANCE V★S STATATRON is a static powered drive for wide range variable speed from in-plant a-c. circuits, available from 1 to 200 hp. Instead of a motor-generator set, the Statatron uses silicon diodes and saturable reactors to rectify the current from a-c. to d-c. These work in combination with a transistorized power exciter to supply variable voltage. Statatron is compact—35% smaller than conventional units. Consists of only three components: Super 'T' d-c. motor, operator's station and control cabinet. Statatron is quiet—vibrationless and low in maintenance cost. Bulletin D-2508.

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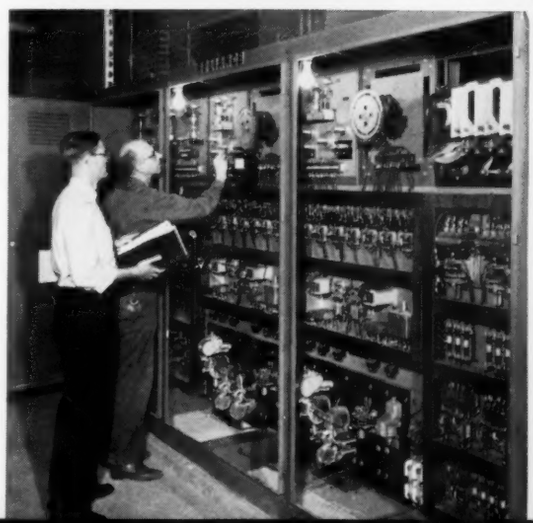

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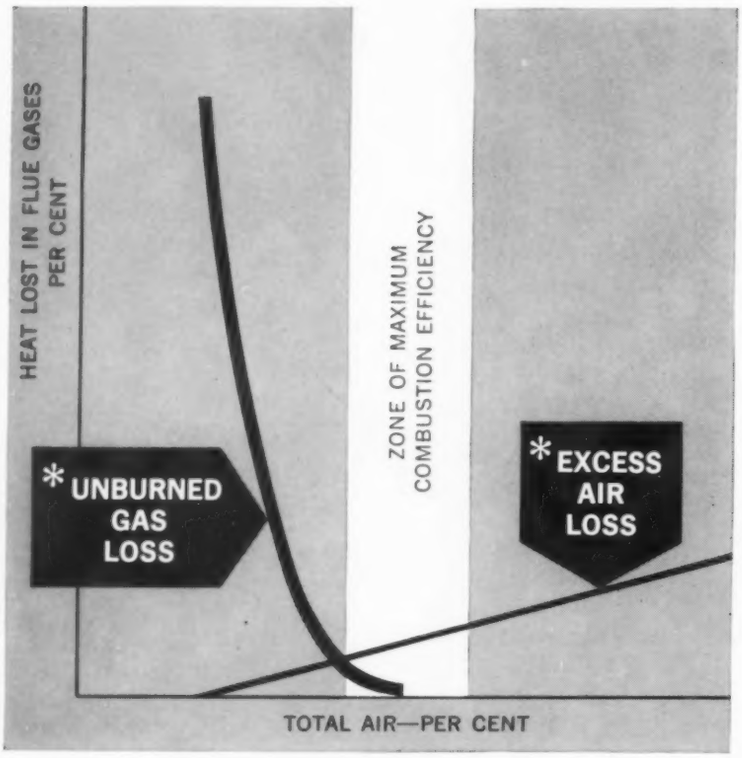
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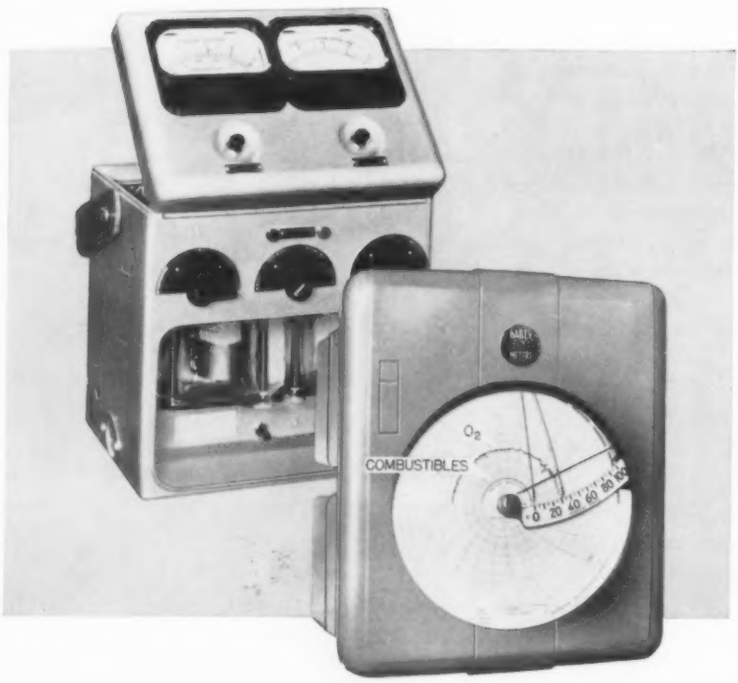

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* Unburned gas loss and excess air loss.

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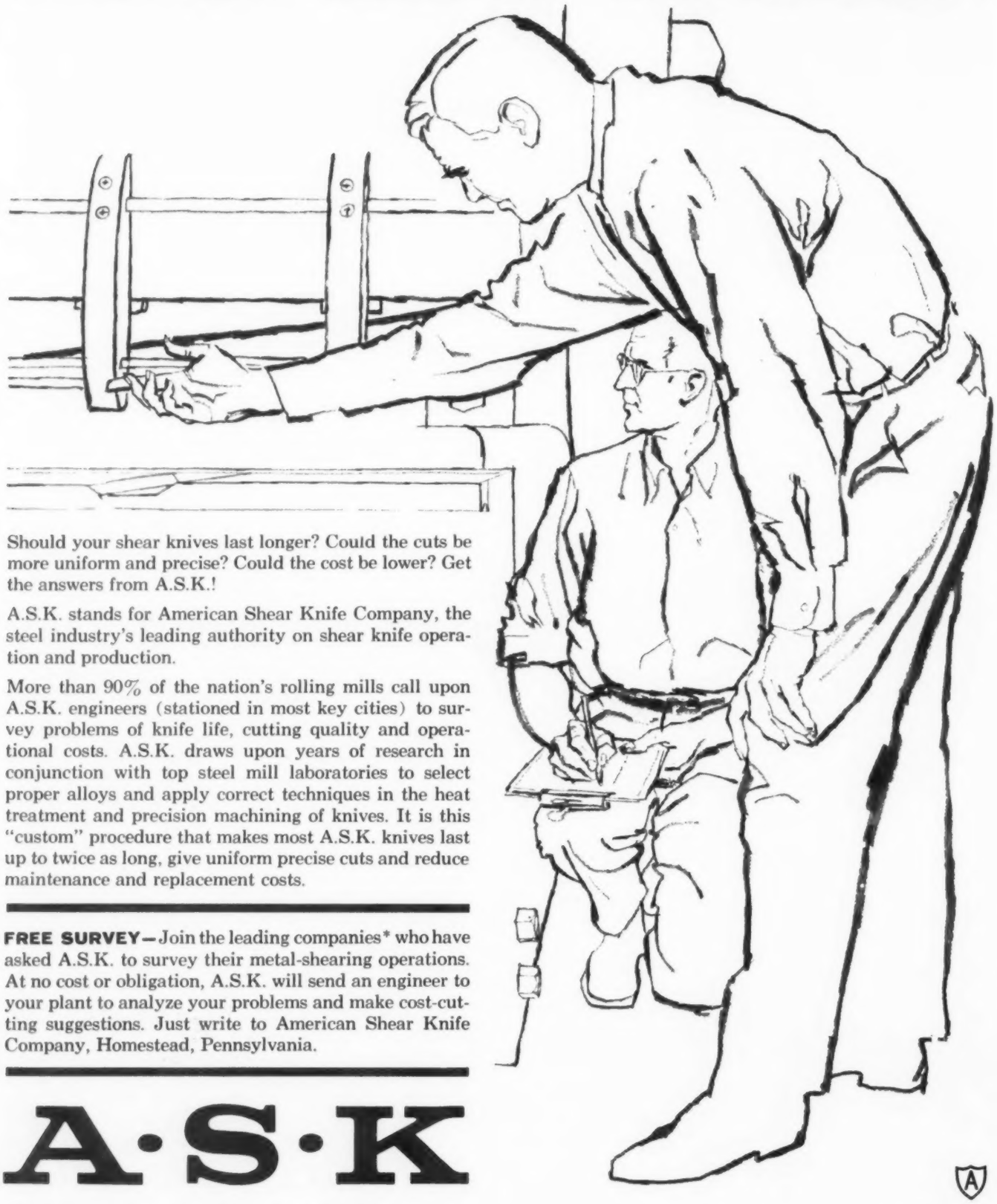

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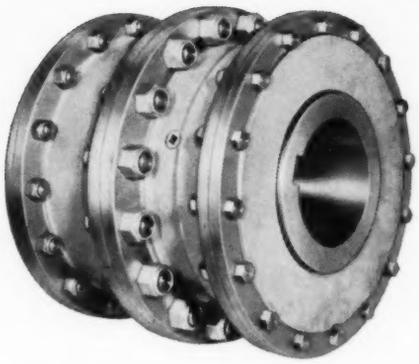

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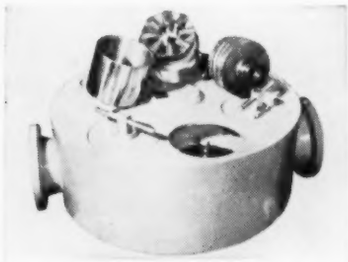

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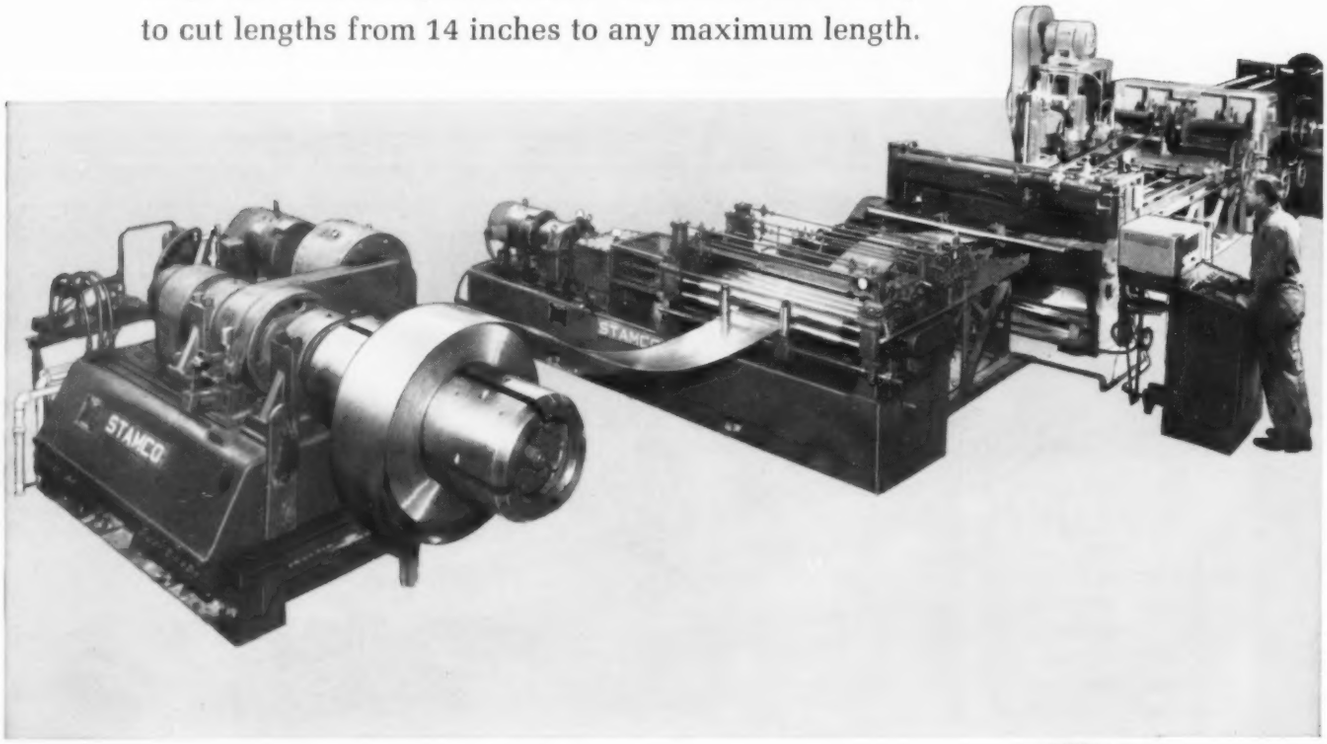
This new shear line is designed to accommodate stock up to 14 gauge, in widths to 48 inches, and in coils weighing a maximum of 20,000 pounds. Accuracy can be held to plus or minus 1/32 inch. It is set up to cut lengths from 14 inches to any maximum length.



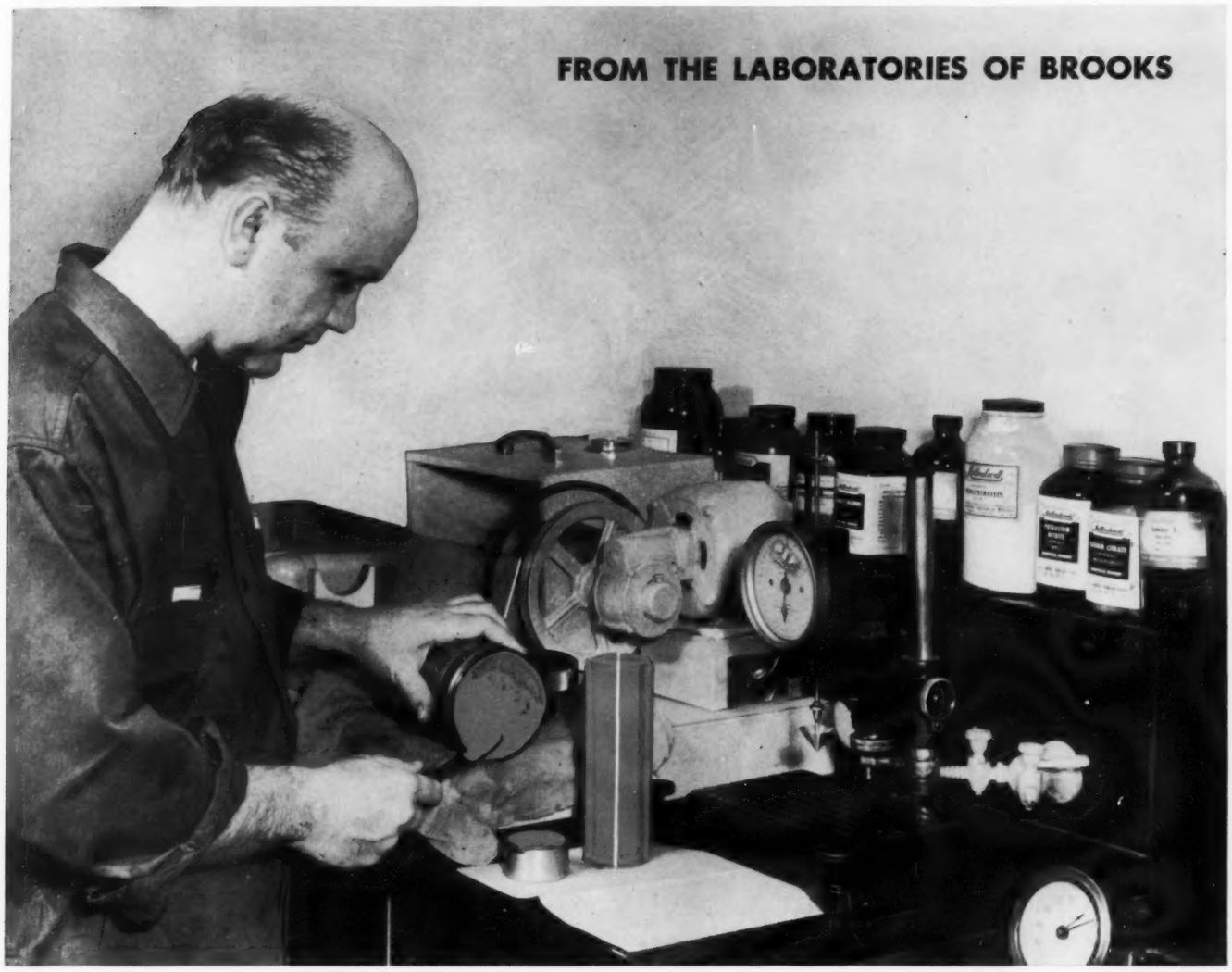
Stamco, Inc., New Bremen, Ohio, U.S.A.

Slitting and Coiling Lines • Cut-to-Length Lines • Flying Shear Lines • Power Squaring Shears • Continuous Process Lines
Ferrous and Non-ferrous Mill Equipment

District Offices, Stamco Sales, Inc.

R. P. Popp, 18450 Livernois, Detroit 21, Michigan
R. P. Popp, 101 Investment Building, Pittsburgh 22, Pa.
I. W. Spraitzar, 159 Main Street, Chatham, New Jersey
W. E. Heineman, 122 West Burlington Ave., LaGrange, Illinois
W. H. Millan, 11955 Shaker Boulevard, Cleveland 20, Ohio

NOW! A NEW LIGHT COLORED LEADOLENE GREASE



LEADOLENE 395 M

Having the same characteristics as LEADOLENE Greases which have been successfully used for years.

E. P. Qualities . . . Worked and Unworked Penetration the same . . . Resists Water Washout . . . Superior Stability . . . Good Pumpability . . . Excellent Polarity to Metal Surfaces.

Talk it over with the BROOKS OIL man near you!

THE BROOKS OIL INTERNATIONAL CO.
EXPORTERS

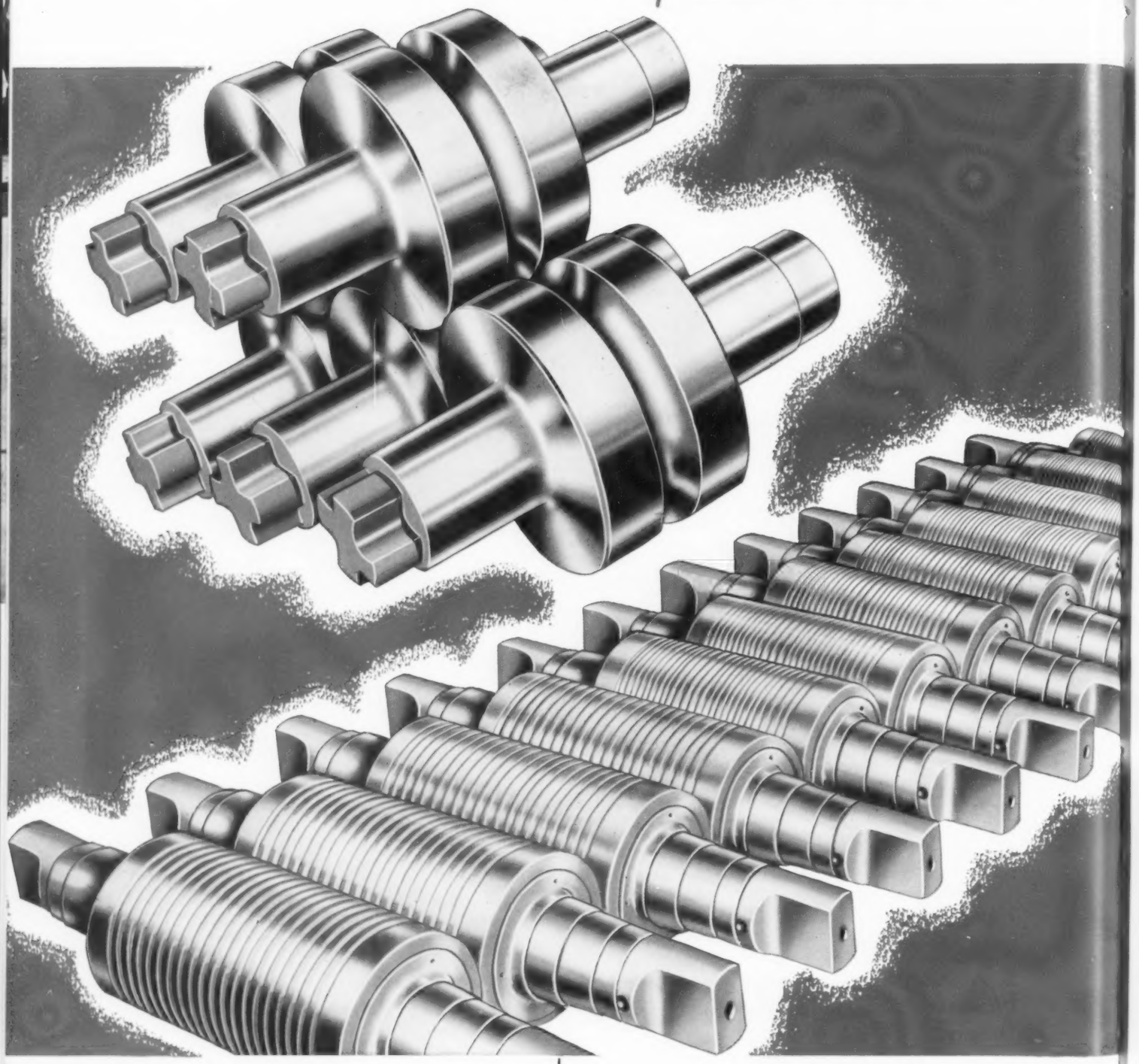
OFFICES AND WAREHOUSES IN PRINCIPAL CITIES
U.S.A. CANADA

The BROOKS OIL Company
Established 1876

General offices and U.S. plant: 3304 East 87th Street • Cleveland 27, Ohio
Canadian offices and plant: 461 Cumberland Avenue • Hamilton, Ontario

Ohio Rolls

Shaping Metal for all Industry



THE OHIO STEEL FOUNDRY COMPANY
LIMA, OHIO

OHIO IRON and STEEL ROLLS

Carbon Steel Rolls	Flintuff Rolls	Denso Iron Rolls
Ohioloy Rolls	Double-Pour Rolls	Nickel Grain Rolls
Ohioloy "K" Rolls	Chilled Iron Rolls	Special Iron Rolls
Nioloy Rolls	Forged Steel Rolls	

PLANTS AT LIMA AND SPRINGFIELD, OHIO. . *Virtually at the center of the Steel Industry*

OR-50

Industry News...

CONSTRUCTION BEGINS ON NEW COLD STRIP MILL

△ Construction has begun on Carpenter Steel Co.'s new cold rolled strip mill building at its West Shore property in Reading, Pa. The new facility, when completed, will replace existing cold rolling capacity at the Reading plant.

Substantial purchases of new mill equipment are to be made as a part of the program, including a sendzimir mill and related equipment for precision cold rolling, and replacement of an existing 4-high cold rolling mill with a precision 4-high mill equipped with gaging and size control devices.

Total cost will exceed $4,500,000, and will take more than 18 months to complete.

YODER TO MAKE PIPE MILL FOR BRITISH FIRM

△ The Yoder Co. has announced receipt of an order from Stewarts and Lloyds, Ltd., Corby, England, for a new continuous electricweld pipe mill.

The mill will incorporate a 450-kc, ultra-high-frequency resistance welder and will manufacture pipe up to 6⅝-in. OD by 0.375-in. wall, at rates up to 75 fpm. It is intended primarily for the production of high-pressure boiler pipe, in both carbon steel and chrome alloys, for a wide variety of industrial applications where unusually heavy wall thickness in relation to diameter is required.

CONTRACT AWARDED FOR DUST REMOVAL SYSTEM

△ A 98-per cent efficient dust clean-up is slated for the Chicago steel plant of Republic Steel Corp. where two open hearth steelmaking furnaces are being converted to the oxygen roof-lance process. Although the amount of the contract, including installation, is approximately $1,000,000, Republic will invest upwards of $3,500,000 in the over-all project, scheduled to be completed by July, 1962.

The air cleaning system being designed by Research-Cottrell, Inc., will handle 300,000 cfm of gas at a temperature of 550 F with an efficiency of 98 per cent. The system will be installed by Swindell-Dressler Corp.

Fumes and dust particles down to submicroscopic size will be removed by the precipitator from the furnace gases. Silicon rectifiers and the Cottrell automation system will be incorporated in the new system to maintain economic and efficient control of the electrostatic precipitator at all times.

BLISS COMBINES PLANTS INTO SINGLE DIVISION

△ E. W. Bliss Co. has announced the consolidation of its Salem and Canton operations into a single Heavy Equipment Division. George Perrault, Jr., presently vice-president and manager of the Salem Division, will manage the new division and his headquarters will be in Salem. Corporate headquarters for the company will continue to be located in Canton.

Geographically, the two plants of the new Heavy Equipment Division are only 30 miles apart and their facilities are complementary. Each plant is equipped to handle heavy metal sections from fabrication or casting through heat treating, machining and assembly and the combining of these two units into a single operating facility with approximately 1,000,000 sq ft of floor space, will enable the company to expand its activities in the custom-built machinery field. The move also provides a more versatile contract manufacturing capability than has previously been available.

BETHLEHEM PATENTS ORE PELLETIZING FURNACE

△ Significant savings in heat and fuel have resulted from an improved iron ore pelletizing furnace which Bethlehem Steel Co. has recently patented.

Bethlehem has seven of these new type furnaces at Lebanon and Morgantown, Pa., where it has been treating efficiently large tonnages of iron ore pellets with outstanding results.

The invention is a shaft-type furnace into which moist balls, or pellets, of concentrated iron ore are introduced at the top. The pellets descend through the shaft of the furnace in which they are heated by hot gases from a separate fuel combustion chamber to about 2300 F. The pellets then descend into another chamber in which they are cooled by a continuous current of air to about 200 F, at which temperature they can be handled.

Since the cooling chamber air becomes burdened with ore dust, it is passed first through a cyclone dust collector, then around heat exchanger tubes. The dust collector and the heat exchanger assure that no dust enters the combustion chamber air stream.

Use of the heated air from the cooling chamber to preheat the combustion chamber draft cuts down on the amount of fuel that would otherwise be required.

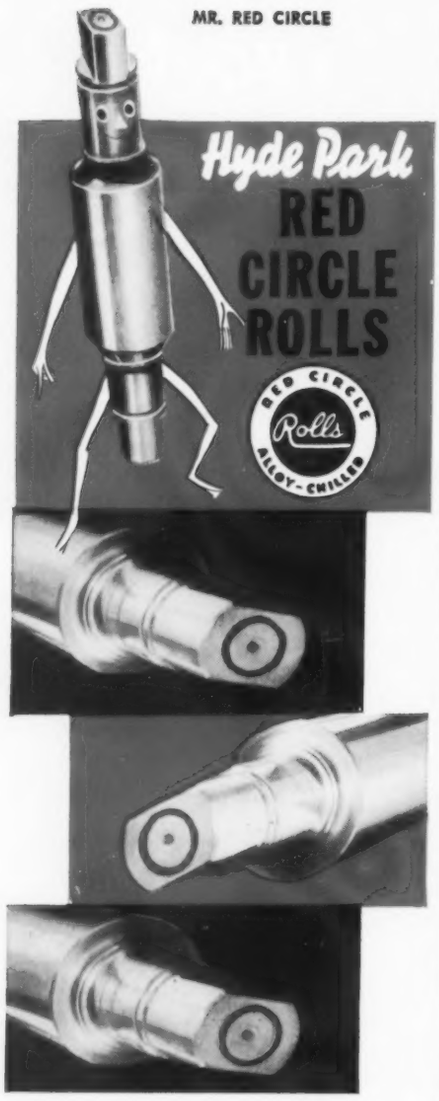
Keeping the dust out of the heat exchanger prevents it from clogging around the tubes, and saves considerably in time and expense in cleaning and repairs.

By way of a bonus, the dust collector prevents the discharge of ore fines into the surrounding atmosphere, effectively lessening any air pollution hazard.

Invention of the improved furnace is credited to P. L. Steffensen, director of Bethlehem Steel's raw materials laboratory at the Lebanon plant.

VOSS APPOINTS ENGLISH SALES REPRESENTATIVE

△ Voss Engineering Co. has appointed Gaston E. Marbaix, Limited, of London, England, as its sales representative in that country.



A Roll for Every Purpose

Our engineers will be glad to work with you in the production of any special rolls or rolling mill equipment.

Nickel Alloy Grain Rolls
Nickel Chilled Rolls
Grain Rolls
Chilled Rolls
Moly Rolls
Nodular Iron Rolls

Hyde Park
FOUNDRY AND MACHINE CO.
HYDE PARK
Westmoreland County, Penna.

Rolls
Rolling Mill Equipment
Gray Iron Castings

Marbaix will represent Voss for all of its products including precision inverted roller levelers, stamped parts flatteners, all allied equipment and high-quality small diameter rolls.

In addition to the appointment of Marbaix, Voss has also completed arrangements for the manufacture of its equipment in England.

According to William H. Rose, president of Voss, this appointment is part of extensive plans for international expansion of the company's activities.

BLOOM ANNOUNCES MOVE OF COMPANY FACILITIES

△ Bloom Engineering Co., Inc., announces the opening of new and larger offices, manufacturing and research facilities. The new company address is Horning and Curry Roads, Pittsburgh 36, Pa.

ENGLISH FIRMS BUY LECTROMELT FURNACES

△ Lectromelt Furnace Division, McGraw-Edison Co., has announced the sale of three large vacuum-steel production units to English firms.

Two of the English-bound items to be manufactured at McGraw-Edison's Lectromelt plant in Pittsburgh are D-H vacuum process units for English Steel Corp., Ltd., works located in Manchester and Sheffield. The equipment will be used for the removal of unwanted gases from molten steel produced in a conventional electrical furnace. Capacities of the two units are 60 and 125 tons respectively.

The other item is a vacuum-arc, consumable-electrode furnace, which is now being installed at the Sheffield plant of Hadfields, Ltd. Rather than subjecting the steel to vacuum processing when it is still molten, this equipment will be used to remelt, under vacuum, ingots produced in a conventional electric furnace. Special-quality ingots up to 30 in. in diameter can be produced.

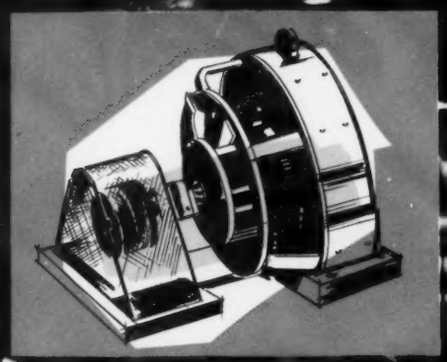
M. H. TREADWELL CO. TO OFFER MOBILE FURNACES

△ M. H. Treadwell Co., Inc., announces that they have been granted patent protection on apparatus

The Pringle Switch with "BOLTED" Pressure silver contacts operates quickly and easily under all conditions. Powerful **bolted** pressure is exerted on the closed contacts with practically no physical effort by the operator.

Find out more about this switch that does a perfect job in your applications every time it's called on to perform. Write for information. Pringle Electrical Manufacturing Company, 1912 North Sixth Street, Philadelphia, Pa.

Pringle



REYNOLDS METALS COMPANY KEEPS ALUMINUM PRODUCTION ROLLING WITH AN ASSIST FROM NATIONAL BRUSHES

TRADE-MARK

Reduction operations at the Corpus Christi Plant of Reynolds Metals Company produce a steady flow of basic aluminum on a round-the-clock schedule. Every component in the power plant must provide exacting performance and rugged reliability to meet production schedules.

"National" Brushes—used in the power generating section—are small but vital components that contribute to uninterrupted d.c. power supply for the aluminum pot lines. For many years these brushes have provided good commutation and life with minimum commutator maintenance.

To National Carbon Company, improved electrical operations mean a positive carbon brush service program. For details, call your "National" Brush Man or write National Carbon Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. In Canada: Union Carbide Canada Limited, Toronto.

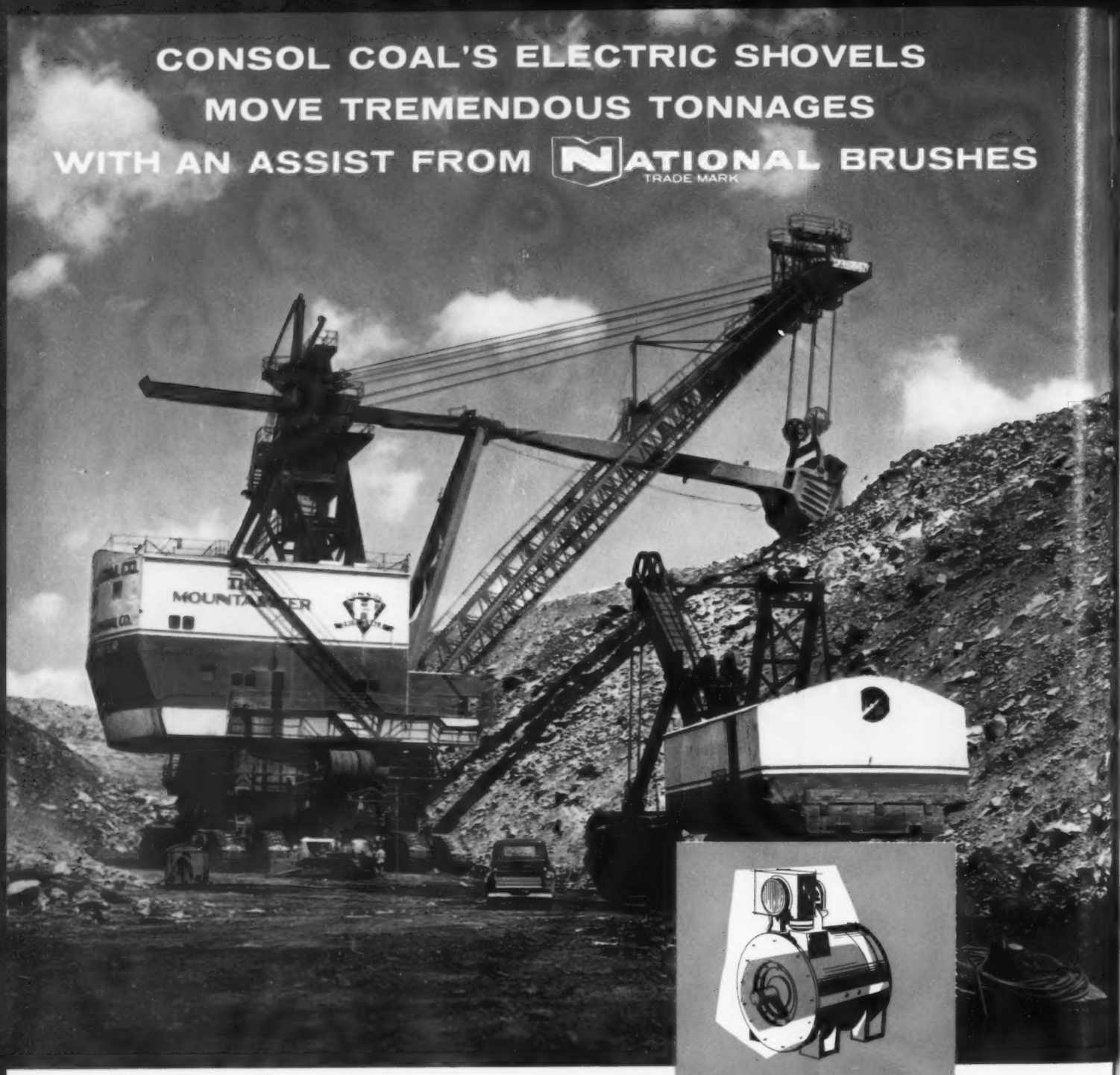
Contact your "National" Brush Man

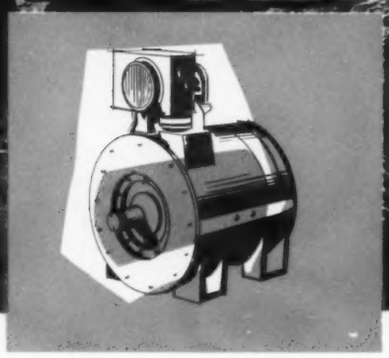
UNION CARBIDE

"National" and "Union Carbide" are registered trade-marks for products of

NATIONAL CARBON COMPANY

CONSOL COAL'S ELECTRIC SHOVELS MOVE TREMENDOUS TONNAGES WITH AN ASSIST FROM NATIONAL TRADE MARK BRUSHES





Huge electric shovels take one tremendous bite after another at the eastern Ohio mines of the Hanna Coal Company, a division of Consolidation Coal Company. The swinging peak loads are extremely demanding on the shovels' electrical system–there is no room here for short cuts on quality.

"National" Brushes–small but vital components on such equipment–offer proved commutation and life under these swinging peak load conditions. A real contribution to sustained production with minimum maintenance.

National Carbon Company offers a positive service program to assist in solving any brush problems encountered today in all types of mining operations. To realize this assistance, just call your "National" Brush Man or write National Carbon Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, New York. In Canada: Union Carbide Canada Limited, Toronto.

Contact your "National" Brush Man

UNION CARBIDE

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NATIONAL CARBON COMPANY

which include mobile furnaces for use in oxygen refining of metals.

Valuable applications for mobile furnaces will be found in the oxygen refining of steel. It is expected that this type of equipment will also be of value in refining nonferrous metals.

The mobile furnaces may be self-propelled and remotely controlled. In some cases other means of propulsion may be indicated such as separate locomotive or car puller. Two or more of these furnaces may be successively blown at one station, making possible the virtually continuous refining of metals at one blowing station.

These furnaces, as presently envisaged, will have the same general conformation as the stationary oxygen furnaces used in the United States. The vessels will rotate in a manner similar to stationary furnaces for adjusting the position of the top opening for the various steps in the steelmaking operation.

As now contemplated the mobile furnaces will be offered in various sizes up to 120-ton capacity. Standard gage tracks will accommodate mobile furnaces up to approximately 20-ton capacity. Furnaces of larger sizes will require tracks of wider gages.

Reduced capital investment and reduced production cost per ingot ton will result from an installation using these mobile furnaces. Also, increased scrap consumption and simplification of raw material handling will result. In addition, this operation will permit a more practical approach to the production of steam from the waste heat.

An installation with this new equipment can be made in existing open hearth buildings with a minimum of alterations. The mobile furnaces will operate at yard level, thus permitting the use of existing overhead cranes.

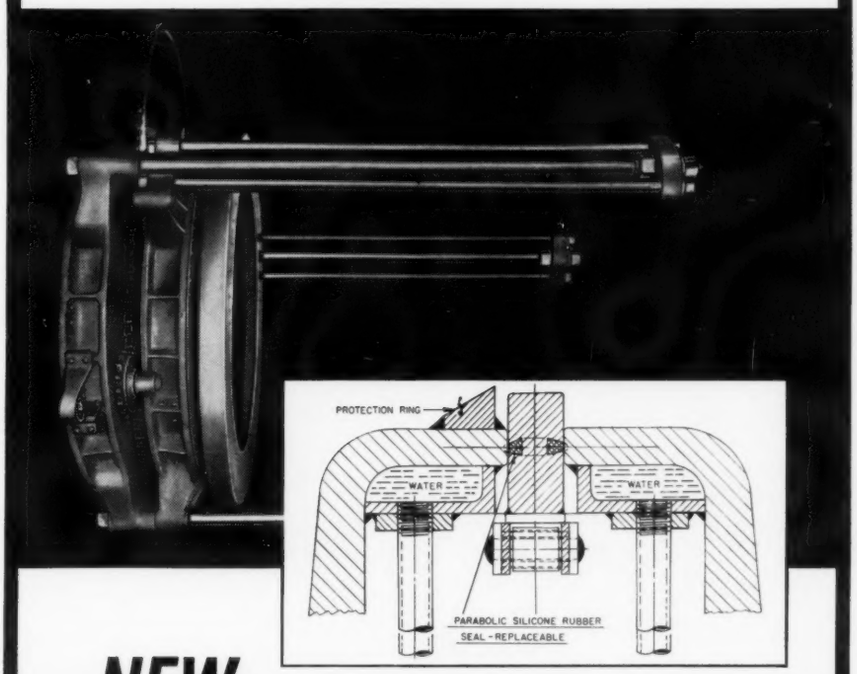
ATLAS STEEL ANNOUNCES EXPANSION PROGRAM

△ The board of directors of Atlas Steels Limited announced that the company will erect a mill for the production of 48-in. wide stainless steel strip and sheet at Tracy, Quebec.

The project will be started immediately and is planned for completion in 2 to 3 years. Total cost of the new plant is estimated at 40 million dollars.

World's First

Water-Cooled, Silicone Rubber-Seated GOGGLE VALVE



NEW... GAS-TIGHT Service for High Pressure Furnaces

Designed for use between dustcatcher and washer, this valve features parabolic silicone rubber seats in the goggle plate, and water cooled flanges. Design provides a tighter, more gas-proof seal than is possible with metal-to-metal seals. *Write for Bulletin V-200.*

BAILEY *Thermal Expansion* GOGGLE VALVES

WILLIAM M. BAILEY COMPANY • 1221 BANKSVILLE ROAD • PITTSBURGH 16, PA.

SCHLOEMANN RECEIVES BLOOMING MILL ORDER

△ An order for a blooming mill has been placed with Schloemann Aktiengesellschaft by the HADIR Corp. (Hauts Fourneaux et Aciéries de Differdange—St. Ingbert—Rumelange S.A.).

This is the third project carried out by Schloemann on behalf of HADIR. A continuous strip mill, built in 1953, was followed by a blooming and slabbing mill in 1954. The new blooming mill will help to step up the output of semi-finished products required for processing by an existing universal beam mill train and a strip mill.

FIRM ACQUIRES INTEREST IN GERMAN COMPANY

△ The Bendix Corp. has announced acquisition of a one third interest in Nieberding and Co. G.m.b.H. of Neuss, Germany, a leading European manufacturer of pneumatic gaging for industry.

Licensing agreements also were concluded between the two firms whereby the German company will manufacture the complete line of precision air gages of the Sheffield Corp., a Bendix subsidiary.

Nieberding also will handle sales of Sheffield's precision measurement instruments, automatic gaging and assembly machines and machine tools in Germany, Austria and Denmark.

Production tooling for manufacture of Sheffield air gaging equipment already is under way at Nieberding, the announcement said, and the German company will develop facilities on a graduated basis for the production of other Sheffield equipment. Dr. Otto Nieberding will continue as managing director.

GE PLANS COMPUTER CENTER FOR DALLAS

△ General Electric Co.'s Computer Department has announced plans for establishing an information processing center at Dallas, Texas. The new center, scheduled for opening next July, will offer computing services to business and industry in Texas and the southwest.

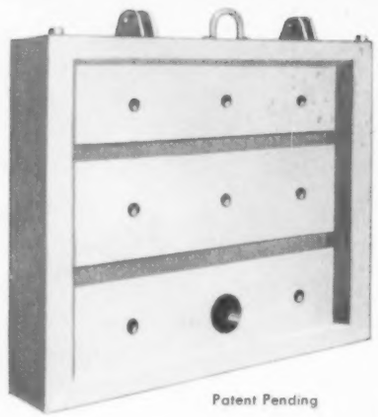
Clair C. Lasher, Computer Department general manager, said the center will be located on the ground floor of a two-story building to be erected in the new Empire Central industrial development four miles northwest of Dallas.

The new center will feature the GE 225 general purpose computer, tape units, high-speed document handlers and other computer peripheral equipment.

The new computer center is one of six scheduled to be opened by General Electric during 1962. Others will be located in Chicago, Washington, Schenectady, N. Y., Sunnyvale, Calif. and New York City. Two are now in operation at Computer Department headquarters in Phoenix. The centers are under direction of Dr. Helmut M. Sassenfeld, manager of applications for the Computer Department.

Computing services will be sold to business and industry within a serviceable radius of the Dallas-Fort Worth area. Emphasis will be placed on applications in such fields as engineering and scientific, banking, insurance, petro-chemical and warehousing.

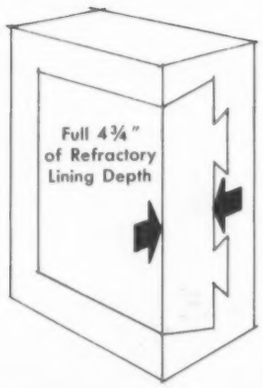
DOUBLE DOOR LIFE

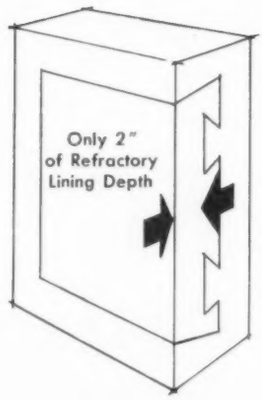


Patent Pending

The new Hutton Ram Type Door features a new *concave* refractory-holding rib design. This increases the uninterrupted refractory thickness area over conventional *convex* rib type doors from 2" to 4¾". Tests in actual open hearth operation obtained 100 to 124 heats before re-ramming required. Ram type Hutton doors eliminate troublesome, costly studding of doors—no clips, studs or welding required to re-ram. Investigate this cost-cutting, field proven door today! FREE BULLETIN 561 fully describes Hutton Ram Type Doors. Write for your copy today.

NEW RAM TYPE HUTTON DOOR	CONVENTIONAL RAM TYPE DOOR





HUTTON

FABRICATING MANUFACTURING CORP.
2736 East 79th Street • Cleveland 4, Ohio
Telephone: EX 1-7432

Open Hearth and Electric Furnace Doors and Frames • Oxygen Lances
Special Steel Mill Fabrications • Water Line Purifiers

1962 IRON & STEEL EXPOSITION

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reserve booth space now

With a continuing program of technological development, plant modernization and maintenance totaling two billion dollars annually . . . the iron and steel industry is America's greatest single market. Well established, successful, attended by a quality audience of 13,000 to 15,000, the Iron & Steel Exposition is held every second year in conjunction with four full days of AISE technical sessions in the same auditorium.

Join with the more than 200 leading companies who use this dramatic medium for making present and future sales to a quality audience that can be reached in no other way. *For Details, Costs and a Booth Floor Plan—write or phone Exposition Manager at AISE (Atlantic 1-6323).*

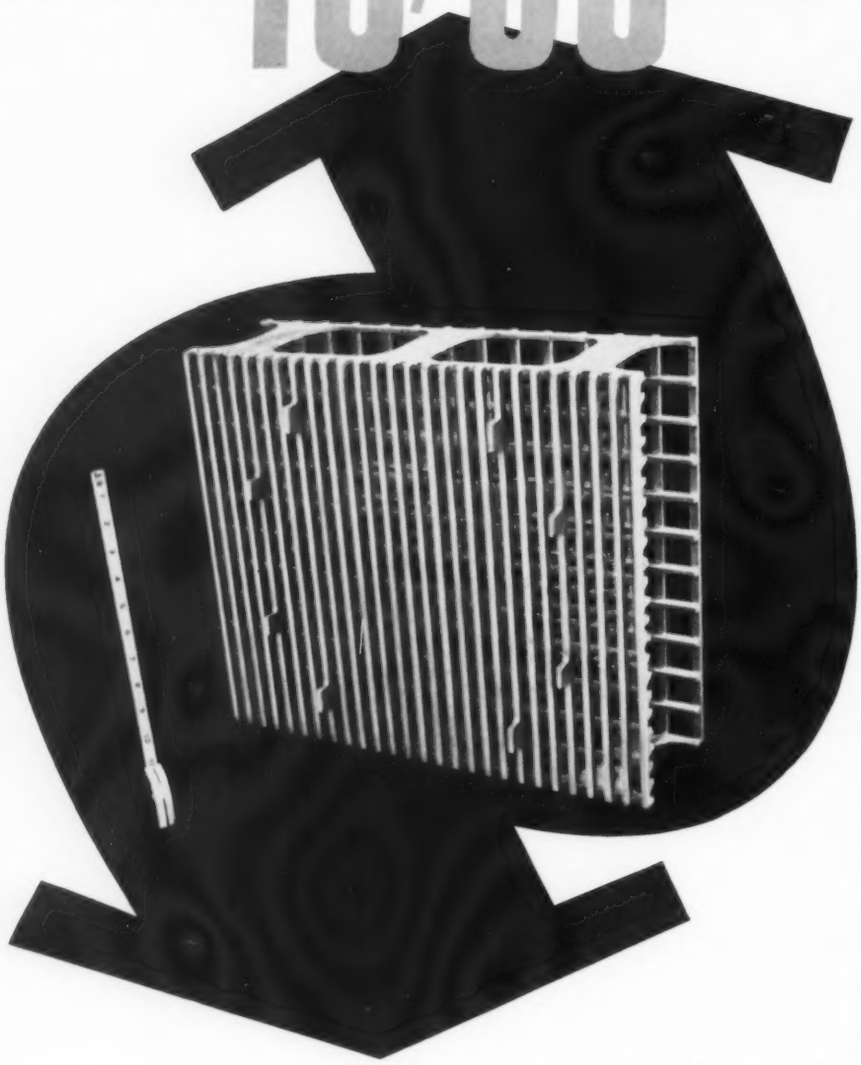
Since 1919 . . . Sponsored, Controlled and Managed by the

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 EMPIRE BUILDING • PITTSBURGH 22, PA.

SEPTEMBER 25, 26, 27, 28, 1962 • CLEVELAND PUBLIC AUDITORIUM

An intricate 15/35 casting—



—cast exceedingly well!

It's a carburizing furnace fixture, alloyed in the HT group for use in the automotive parts industry.

If a high alloy casting experience beginning in 1922 has any meaning—if having modern facilities in the three major casting types (static, centrifugal and shell-molded) has any meaning—if being in a position to provide any degree of finish desired has any meaning—that meaning is that you will get from Duraloy sound castings properly alloyed.

We can produce single castings up to 10 tons or assembled units to any size or shape that can be shipped and handled in transit. Bulletin G-261.

DURALOY

ALLOY CASTING INSTITUTE ACI MEMBER

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
CHICAGO OFFICE: 332 South Michigan Ave., Chicago, Ill.
DETROIT OFFICE: 1025 Maple Road, Troy, Michigan
HOUSTON OFFICE: 4101 San Jacinto, Houston 4, Texas

In addition to computer time, the center will offer systems studies and programming services to area customers. Dr. Sassenfeld said the center will also be used to back up other General Electric computer installations in the area and for sales demonstrations.

The Computer Department will occupy about 9300 sq ft of the new building. In addition to the computer installation and sales offices, the center will provide customer training facilities.

AMERICAN AIR FILTER MERGES SALES OFFICES

△ Two Cincinnati, Ohio, sales offices of American Air Filter Co., Inc., have merged. The AAF branch office joined Helburn Engineering to form a single office under the latter's name.

I. B. Helburn is the manager of the combined office, while Walter H. Reiger, former branch manager, becomes a senior partner in the firm, which will continue to be located at 1836 Dana Ave.

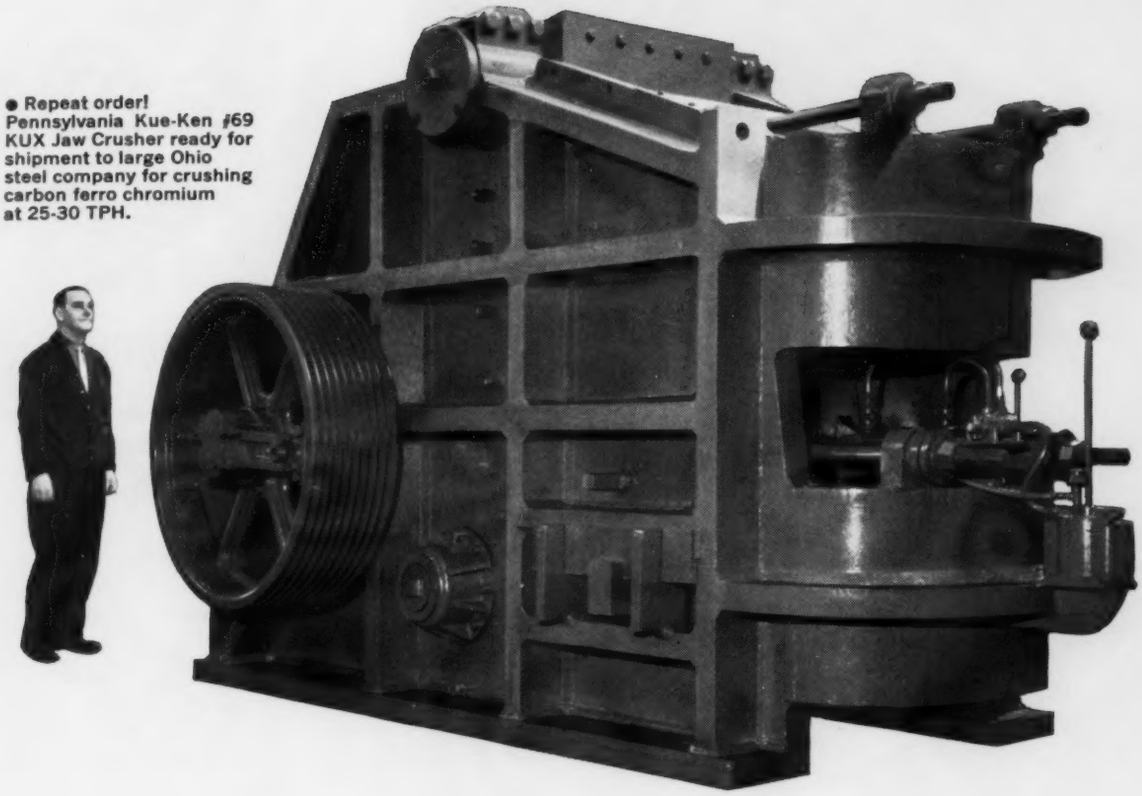
The Cincinnati Branch's suboffice in Dayton also will become a part of Helburn Engineering.

NATIONAL STEEL ADDS ORE CARRIER TO FLEET

△ SS. *Paul H. Carnahan*, newest boat in the National Steel Corp. fleet of lake ore carriers, was christened November 2. The addition of the "Carnahan" increases the National Steel fleet to eight boats which are operated by the Hanna Mining Co.

The "Carnahan" was converted into an ore carrier from the former T-2 Tanker "Atlantic Dealer" at the Lorain, Ohio, yard of the American Shipbuilding Co. The major alteration consisted in cutting away the tanker's bow and stern sections and refitting them to a new midbody especially constructed for the transportation of iron ore.

In the conversion, the length of the boat was increased from 523 ft to 730 ft and the beam from 68 to 75 ft. Cargo capacity was increased from 15,620 to 21,200 long tons. The boat is equipped with 6000 hp, has an estimated normal speed of 16 miles per hr and is manned by a 39-man crew.



● Repeat order! Pennsylvania Kue-Ken #69 KUX Jaw Crusher ready for shipment to large Ohio steel company for crushing carbon ferro chromium at 25-30 TPH.

another PENNSYLVANIA KUE-KEN for crushing ferro alloys

Pennsylvania Kue-Ken Jaw Crushers are fast becoming an accepted standard for crushing ferro alloys in the steel industry.

In plant after plant, primary and secondary reduction of ferro alloys from 10″ to 5″ to 1″ and even smaller is efficiently and economically handled by these crushers with the famous "crushing without rubbing" principle.

The tough, abrasive characteristics of these ferro alloys make the Pennsylvania Kue-Ken Jaw Crusher the ideal machine for the job.

GREATER CAPACITY—BETTER PRODUCT

Consider these advantages when comparing the KUE-KEN with overhead eccentric or standard double toggle jaw crushers:

- 2 to 5 times greater capacity, because of higher crushing speeds.
- Evenly crushed product, because coarse material does not have as much time to drop out of crushing zone.
- No rubbing or grinding action because KUE-KEN crushes by pressure only.
- Jaw plates last 5 to 10 times longer because material is gripped *squarely*, minimizing wear.
- Low power requirements, because of jaw plates meeting material *squarely*.

TEST FACILITIES

Let us run a test sample on your material in our laboratory. The results should be convincing.

Write for free Bulletin 5015.

PENNSYLVANIA CRUSHER DIVISION

BATH IRON WORKS CORPORATION
WEST CHESTER, PENNA.

PENNSYLVANIA CRUSHERS

BATH-BUILT

ASEA

builds world's largest load rated cell... 7 million pounds

Rated at 7,000.000 pounds, the largest capacity Pressductor, now being built in Sweden for a U. S. steel mill, measures 25"x24"...and is only 3" thick. Its output voltage is sufficient to drive an instrument or relay with no need for amplifier.

ASEA Pressductor's error of measurement, under normal conditions, is within ±1% of actual value between 10-100% nominal load. Under ideal conditions, even better accuracies may be obtained.

In service at many modern rolling mills, ASEA Pressductors are proving their suitability for the most difficult applications where dirt, dust and moisture problems exist. ASEA Pressductors withstand considerable overload without damage...are free of hysteresis (particularly important in automatic system regulation)...resist lateral forces...offer interchangeability of units (no recalibration necessary)...and both calibration and performance are unaffected by age.

The superiority of ASEA Pressductors is now being proved in the following applications:

Measurement of:
rolling forces and strip tension in rolling mills ■ propulsion forces in ships ■ web tension in paper machines ■ column pressures in buildings

Weighing of:
coils in rolling mills ■ ore, etc., in hoppers ■ loads on cranes, hoists, elevators ■ charges in electric furnaces

Overload protection:
for transportation and handling equipment

Future planned applications include:
Measurement of:
rocket test stand thrust ■ tension of conveyor belts ■ torque in sluice gate hoists ■ pull in carrying cables and drag lines ■ drilling pressures for deep drilling

Weighing of:
trucks, railway cars, aircraft, etc., on loading platforms

Write for detailed descriptions of ASEA Pressductors and the advantages they offer to your specific job application.

U. S. Sales and Service: ASEA ELECTRIC, INC.
East Coast: 500 Fifth Avenue, New York 36, N. Y.
West Coast: 55 New Montgomery Street, San Francisco 5, California

"ASEA world pioneer in electrical products for industry"

Proof!

Ramtite® Performance *Again Proved* in Strip Mill HEATING FURNACE

HOT ZONE ROOF!

INSTALLATION OF **SPECIAL SUPER RAMTITE No. 25** MADE IN AN EASTERN STRIP MILL* OUTLASTED ADJACENT CONVENTIONAL REFRACTORIES—INSTALLED AT THE SAME TIME—THREE TO ONE!

NOW THE ENTIRE FURNACE IS LINED WITH RAMTITE PRODUCTS!

Proving . . . RAMTITE Lasts . . . and Outlasts!

"THERE'S A RAMTITE PRODUCT FOR EVERY REFRACTORY USER"

*Name Upon Request

The Ramtite Co.
DIV. OF THE S. OBERMAYER CO.
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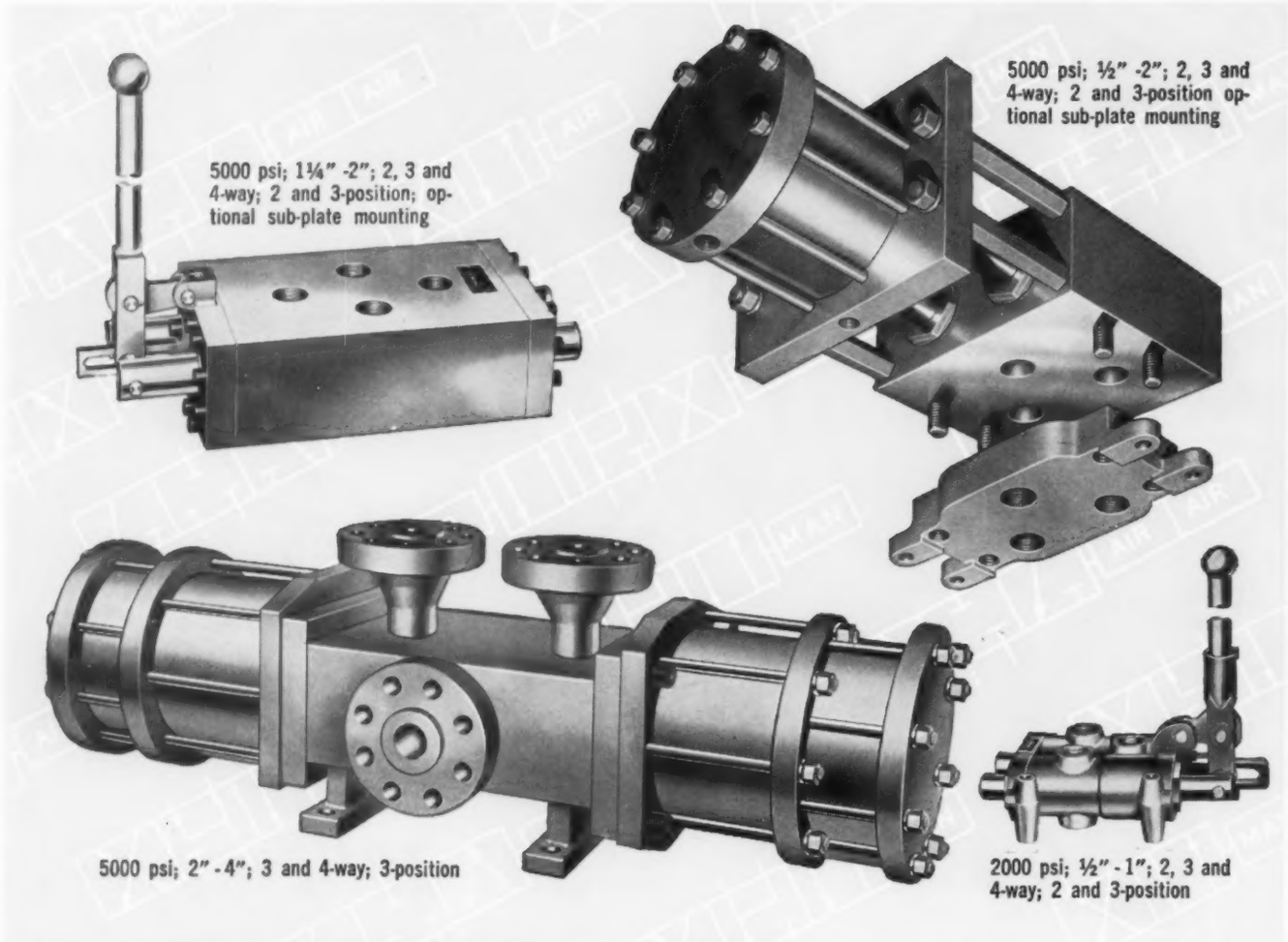
Please send:

☐ General Information about RAMTITE. May be particularly interested in your refractories for_____
☐ Representative (without obligation)

Company Name_____
Attn. Mr._____ Title_____
Address_____
City_____ Zone____ State_____


5000 psi; 1¼" -2"; 2, 3 and 4-way; 2 and 3-position; optional sub-plate mounting
5000 psi; ½" -2"; 2, 3 and 4-way; 2 and 3-position optional sub-plate mounting
5000 psi; 2" - 4"; 3 and 4-way; 3-position
2000 psi; ½" - 1"; 2, 3 and 4-way; 2 and 3-position

for water or oil service

HUNT *Hydraulic Valves*

zero leakage • shock-reducing operation • sizes from ½"- 8" • pressures to 5000 psi

If you're designing or operating hydraulic systems requiring valving of *raw* water, soluble oil and water, or oil, and if you're interested in precise control, positive shut-off, reduction of shock and hammer, plus years of trouble-free operation . . . you'll find it worthwhile to investigate Hunt's complete line of hydraulic valves, featuring *resilient U-packers*. The higher the pressure, the tighter the seal!

You'll have a choice of 3 pressure ranges, 2000, 3500 and 5000 psi . . . a choice of sizes from ½ through 8 inches . . . a choice of manual lever or remote pilot actuation . . . a choice of types — 2-way, 3 and 4-way, 2 or 3-position . . . a choice of steel or high tensile cast or forged brass bodies and direct or sub-plate mounting in many sizes. You'll even find double check types, capable of withstanding pressure in both directions without external check valves, ideal for hydrostatic testing of tubes, pressure vessels and similar items.

Take advantage of Hunt's years of experience in hydraulic control. Call in your Hunt representative for recommendations today.

For more information, write for Bulletin 604. Address Hunt Valve Company, Salem, Ohio, Dept. ISE-1161.

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VALVES

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Mill Type Cranes

TO SPECIFICATION...

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

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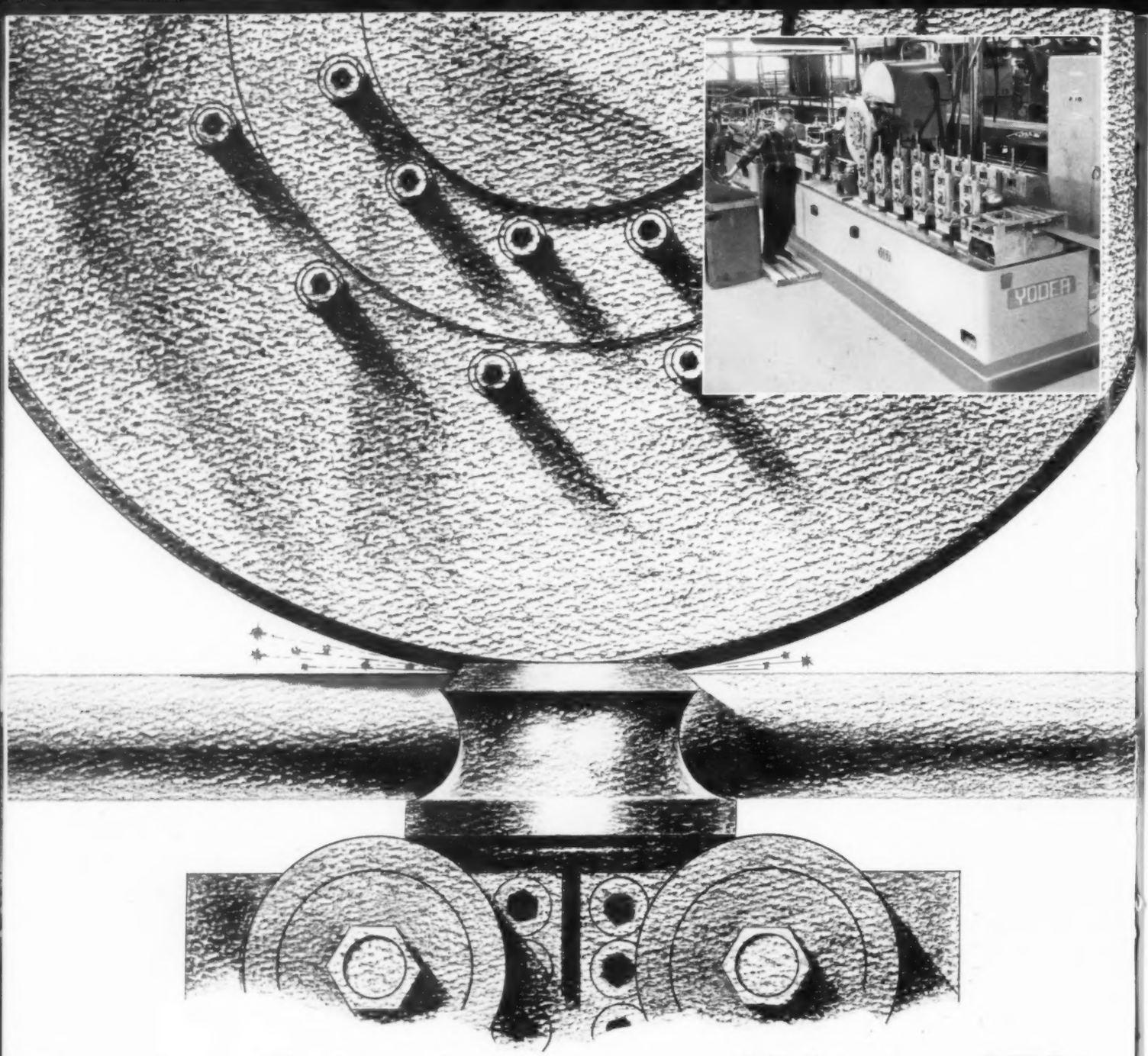
WILLOUGHBY (CLEVELAND), OHIO

DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES



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WITH THE NEW YODER

"TYPE V" PIPE AND TUBE WELDER . . . VAPOR COOLED!

Thousands of hours of tests and actual production point up the major productivity increases achieved by the new Yoder "Type V" Welder. The new Welder is available as a replacement unit for existing equipment or as an original component of a new Yoder pipe or tube mill.

The advanced design and engineering of the Yoder "Type V" Welder is described in a new brochure. This valuable information can be yours by return mail. Send the coupon at the right . . . today!

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5495 Walworth Avenue • Cleveland, Ohio

ENGINEERING YODER MANUFACTURING

Gentlemen:
Please send me full details on the new Yoder "Type V" vapor-cooled pipe or tube welder.

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Company_____

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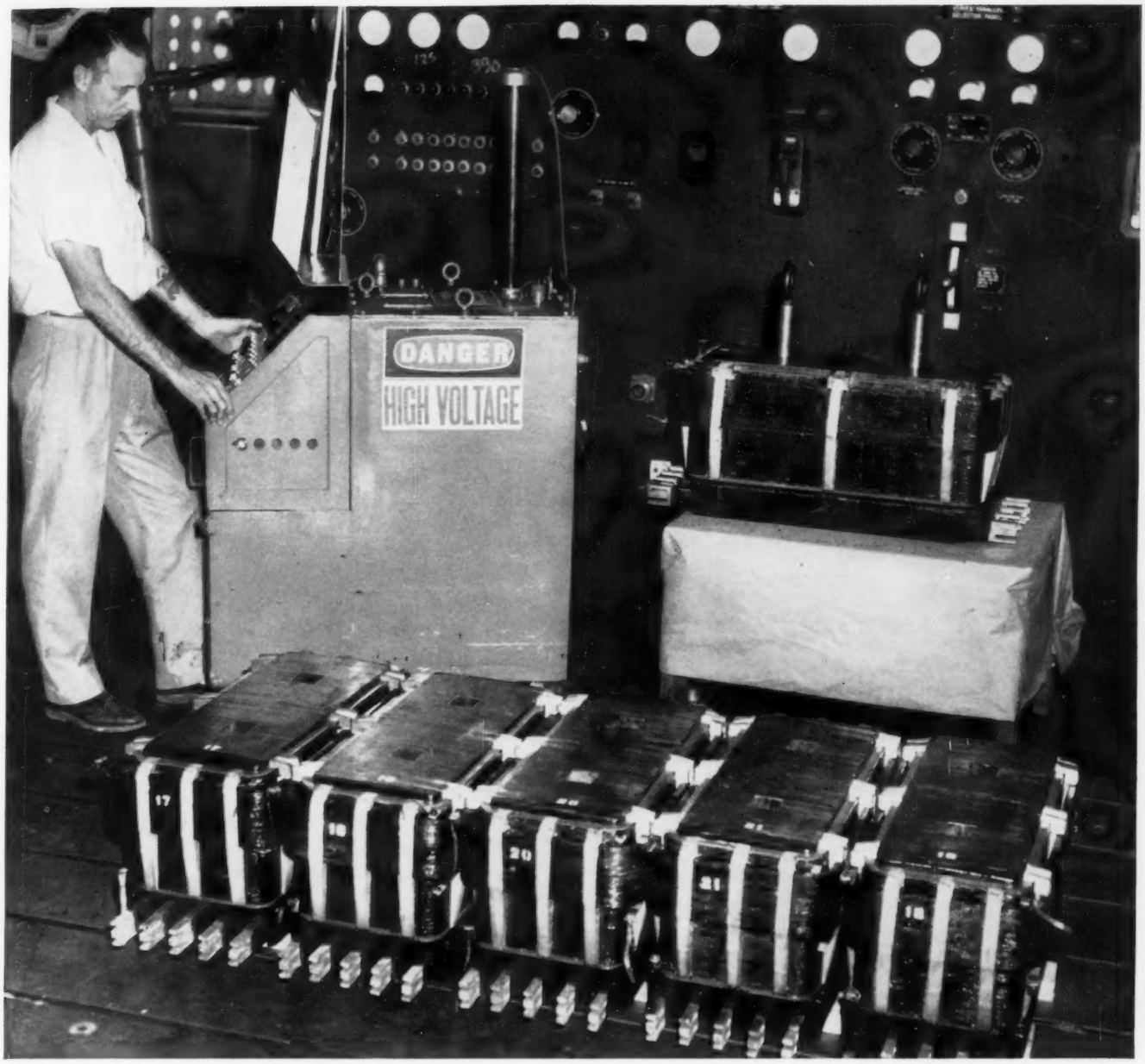

NATIONAL COIL'S TESTING KNOW-HOW HELPS ECONOMIZE ON FIELD COIL RECONDITIONING

These field coils for a 3500-hp D.C. steel mill motor were reconditioned by National on a rush basis—10 days from pick-up to delivery. The work included cleaning and testing, dipping and baking, and replacement and reinsulation where required.

Despite the rush nature of the job, National applied its usual thorough testing. Considerable savings resulted to the customer. The customer had made a-c tests in his mill indicating pole face windings were OK but National also made d-c polarization index tests showing insulation was not satisfactory. After thorough drying, varnishing and baking, further tests assured insulation was fully restored without replacement.

In this application, National's know-how prevented future trouble—but avoided the expensive way of correcting it. The same know-how can assure you of maximum dependability on your coil or rebuilding jobs. For information contact National's Columbus plant... HUdson 8-1151... or check the nearest National field engineer.

DIVISION OF

National Electric Coil

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McGRAW EDISON

Why do we say fulfills the promise

For single function or automated system... our Systemation concept is fitted to your actual needs

In crude definition, automation merely means "to make automatic." In implication, however, automation carries strong promise of low-cost production. It is in the area of lowering costs, some feel, that automation has most frequently missed its potential.

The engineering genius which can concoct sophisticated circuitry . . . join computers, primary detectors, instruments, processing equipment . . . too frequently overlooks the fundamentals of thorough *process knowledge* and such basic problems as the maintenance costs associated with automated systems.

Prudent investment of key importance

The *Systemation* concept is built around lowering *your* processing costs, increasing *your* productivity, improving *your* quality control. The starting point is not "what can be automated" but rather "what automation can be economically justified under your conditions of production."

Allis-Chalmers is thoroughly qualified to help you make *prudent* investment decisions about equipment and instrumentation.

Balanced judgment in depth

Long a supplier of control systems, a broad line of industrial processing and electrical generation, transmission, distribution and utilization equipment, A-C has an intimate knowledge of industrial processes. With the acquisition of Consolidated Systems Corporation last year, Allis-Chalmers extended its ability in the areas of data gathering, handling and utilization. CSC provides such experience acquired from more than 500 successful system projects.

Recently, Allis-Chalmers, Consolidated Systems and International Business Machines Corporation effected a nonexclusive mutual agreement relating to the production and marketing of automated control systems and processes.

For the typical system, Allis-Chalmers takes functional responsibility for the system using IBM data processing computer equipment, CSC specially engineered data conditioning equipment and instrumentation, and A-C basic and auxiliary industrial processing equipment. Now, Allis-Chalmers brings a balance of specialized judgments to bear on your problems . . . drawn on significant experience . . . to make major "contributions to the art" in many phases of *Systemation* and help you be sure before you invest.

Feasibility study shows opportunity

Your first step to Systemation *is a thorough feasibility study which spells out your opportunities for savings and puts a clear figure on the costs. Call or wire your nearest A-C office, or the Industrial Equipment Division, Allis-Chalmers, Milwaukee 1, Wis.*

Systemation is an Allis-Chalmers servicemark.

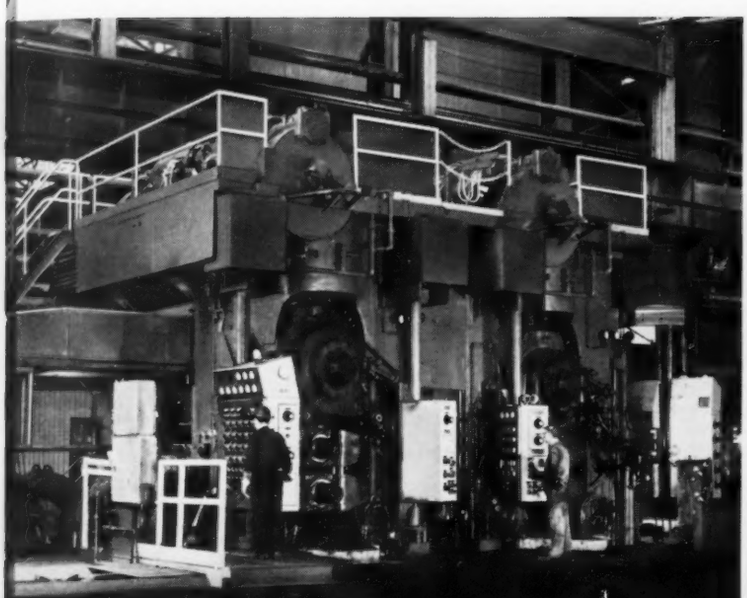
Systemation*

pays its way

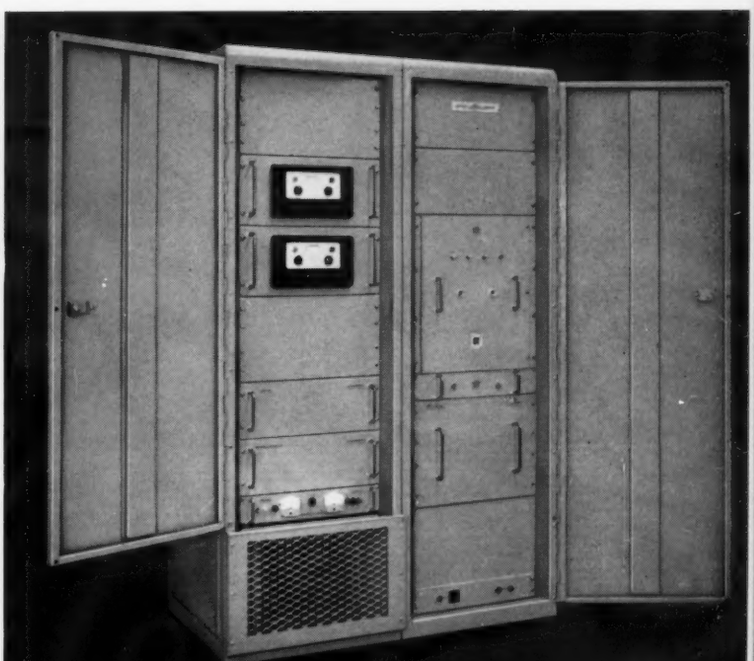
ALLIS-CHALMERS

A-1531

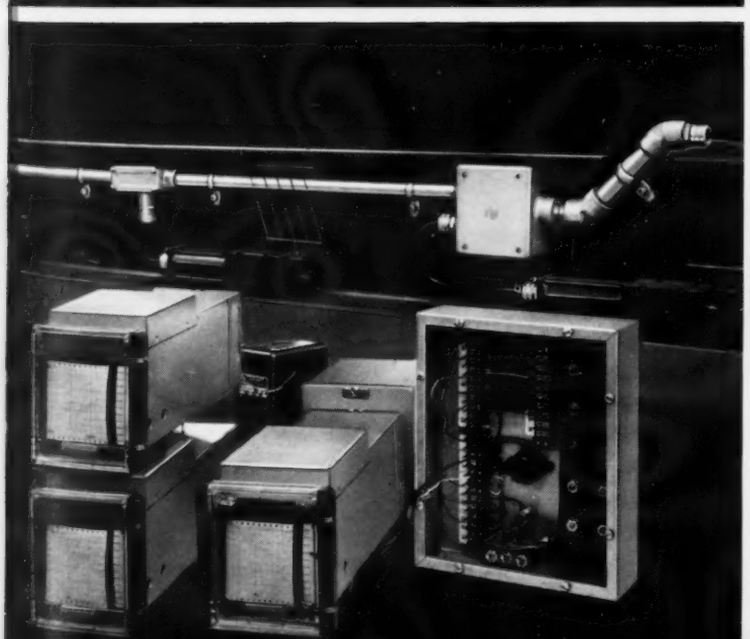
Systemation of automation?



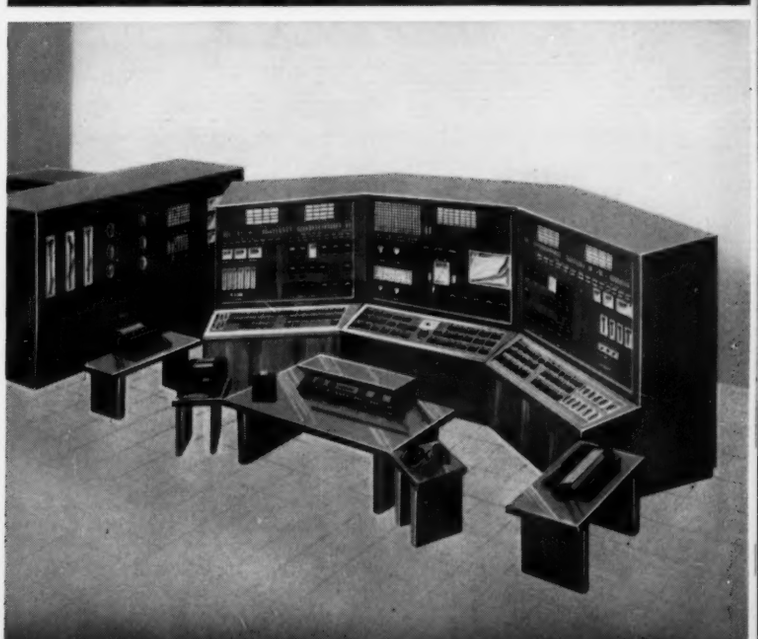
HIGH SPEED TEMPER MILL features include: automatic digital extensiometer to indicate strip extension (hardness pickup); automatic slowdown for rolling maximum length at rolling speed, yet prevent mandrel explosion or tail-end roll damage.



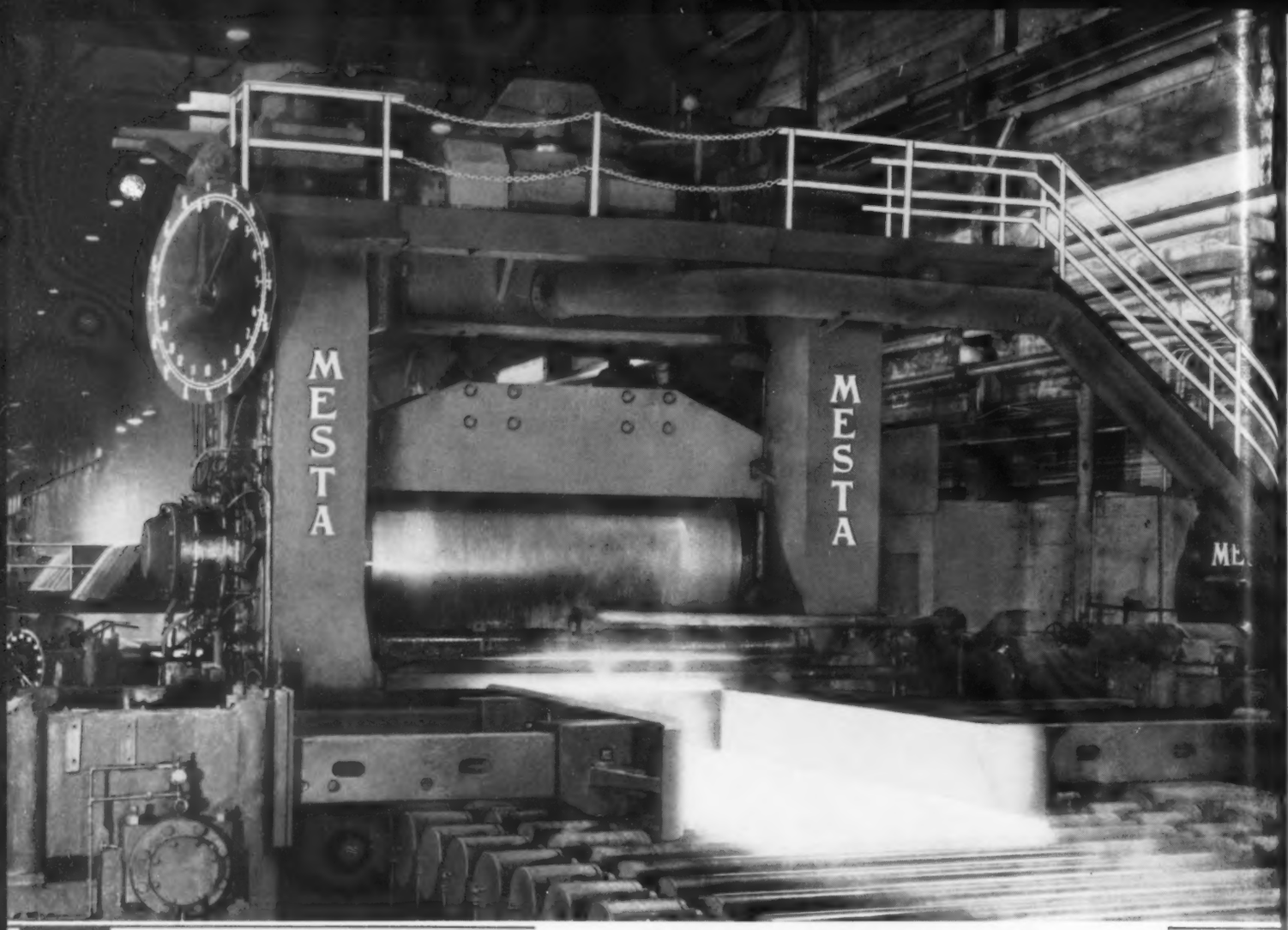
PRECISE AUTOMATIC GAUGE CONTROL for thin tin with automatic screw reset.



AUTOMATIC BED DEPTH CONTROL for traveling grate in GRATE-KILN iron ore pelletizing process.



CENTRALIZED CONTROL ROOM for generating plant using one computer to automatically control two units for start-up, operation and shutdown.

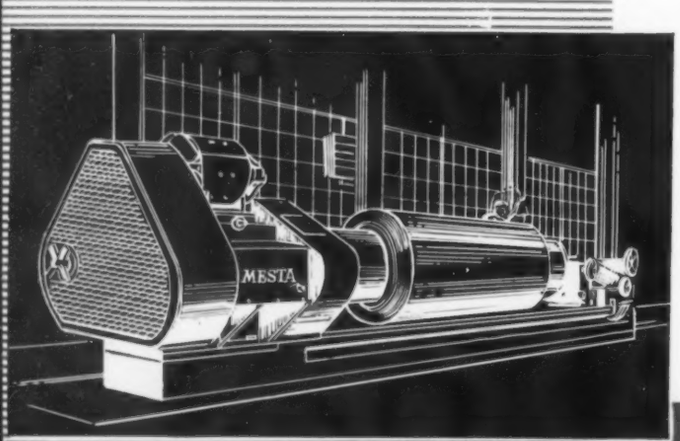


MESTA 148" Four-High Reversing Plate Mill
at Fontana Works of Kaiser Steel Corporation.

PLATE MILLS

designed and built by

MESTA



Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

Personnel News...

Leonard C. Rose, formerly executive vice president, has been elected president and a director of The Colorado Fuel and Iron Corp. **Alwin F. Franz,** who has been president since 1952, was named chairman of the board. **Charles Allen, Jr.,** who has served as chairman since 1945, will maintain his association with the corporation as chairman of the executive committee.

Michael F. Hazel has been appointed president of the Oil Well Supply Division of U. S. Steel Corp. Formerly executive vice president of the division, he succeeds **Fred F. Murray** who retired October 31. Mr. Hazel joined Oil Well Supply at the Imperial works plant in Oil City, Pa., as an engineer trainee in 1930. In 1932 he transferred to Texas and spent the next four and a half years as service engineer in Kilgore and Conroe, Tex. In 1937, Mr. Hazel was appointed sales manager of the West Texas District, and assistant division sales manager at Houston in 1942. In 1946, he was made assistant general manager of sales and in 1948, was appointed general manager of sales. In 1951, he was named director of engineering, and in 1955, he was appointed vice president—sales, which position he held until his appointment as executive vice president on January 1, 1961.

E. L. LaGrelius has been appointed to the newly-created position of plant manager, Eastern Stainless Steel Corp. Mr. LaGrelius was supervisory metallurgist for American Steel Foundries in Chicago, and general foreman for the same company in Verona, Pa. He later became assistant plant manager for Allied Iron Works in Chester, Pa., and vice president of operations for the Alloy Precision Casting Co. in Cleveland, Ohio. Joining Eastern as a research metallurgist in 1949, Mr. LaGrelius has served as assistant to the vice president and general manager prior to his present appointment.

Frank M. Keelan has been named assistant superintendent of the Blast Furnace Department at Republic Steel Corp.'s Chicago district plant. He succeeds **John J. Barrett,** who died July 8. With Republic for 19 years, Mr. Keelan joined the company in 1942 as a laborer in the Open Hearth Department at the Cleveland district plant. In 1947 he was placed in Republic's first technical operating training program to develop operating supervision for the company. He has been general foreman of the Nos. 5 and 6 blast furnaces in Cleveland since 1959.

Jay I. Dodson was named superintendent of the Metallurgical Department at Kaiser Steel Corp.'s Fontana plant. He came to Kaiser in 1953 as product metallurgist, open hearth and foundry. In 1956, he was named senior metallurgist, Iron and Steel Division. He transferred to the Oxygen Steel Production Department in 1957 to become a melter foreman and was named general foreman two years later. In February of this year, Mr. Dodson was named assistant superintendent, metallurgical, primary, the position he held up to his present appointment. He was employed as a metallurgist at United States Steel's South works in Chicago, 1948–51.

Albert A. Evans has been appointed general mechanical foreman for the 25-in. mill and the Structural Finishing Department of The Colorado Fuel and Iron Corp.'s Pueblo plant. Mr. Evans had been serving as foreman in the rod mill since 1955, having worked previously in the seamless tube mill, rod mill, rail mill mechanical and in the 40-in. mechanical. He joined CF&I in 1952 in the Mechanical Department.

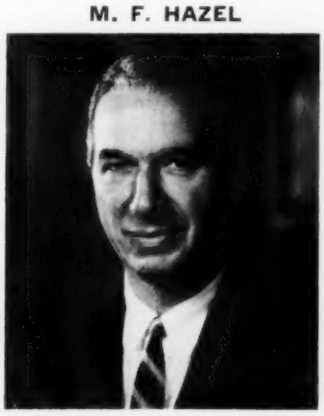
James F. Morrill has been named assistant to the superintendent of the open hearth shop at Republic Steel Corp.'s Warren district. He joined Republic as a combustion engineer at the Buffalo, N. Y., plant in 1959.

Ward B. Browning, Jr., has been named chief engineer of the Armco Division of Armco Steel Corp. He succeeds **John B. Whitlock** who has retired. Mr. Browning joined Armco in 1941, and held various

L. C. ROSE

A. F. FRANZ

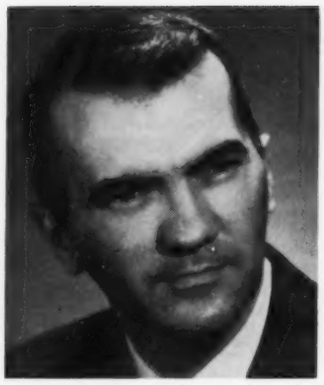
M. F. HAZEL



E. L. LaGRELIUS

W. B. BROWNING, JR.

R. T. RICHMOND



W. L. SACCANI

A. T. ALLEN

maintenance and general engineering assignments. In 1957, he was promoted to assistant works engineer of the Butler, Pa., works. He was named assistant chief engineer of the Armco Division in 1960.

Richard T. Richmond has been named chief engineer at Republic Steel Corp.'s Youngstown district. He succeeds **J. L. Hough** who recently was transferred to Republic's Central Alloy Steel District. Mr. Richmond joined Republic in 1956 as a member of the Engineering Department at the company's Cleveland steel plant. He was promoted to assistant chief engineer in 1960, the position he held until taking over his new duties.

Walter L. Saccani has been appointed superintendent of the Oxygen Steel Production Department at Kaiser Steel Corp.'s Fontana plant. He came to Kaiser Steel in 1959 as general foreman, pits and auxiliaries, open hearth. He then became assistant superintendent of oxygen steelmaking and was assistant superintendent of the open hearth prior to his present appointment. From 1950–59 he was with the Steel Division of Ford Motor Co. as general foreman in the Open Hearth Department. Prior to that he was a process engineer for two years with Carnegie Illinois Steel Corp.

Arthur T. Allen has been named mill superintendent of the Precision Strip Mill Division of Solar Steel Corp. Mr. Allen, a graduate of Republic Steel Corp.'s technical operations training program, was acting general foreman of Republic's Strip Steel Department at Warren, Ohio. He was with the firm 14 years.

William A. Bringman has been appointed assistant superintendent of the Open Hearth Steel Production Department at Kaiser Steel Corp.'s Fontana plant. He joined Kaiser in 1960 as masonry engineer in the Masonry Department. In January, 1961, he was named assistant superintendent of masonry, the position he held to his present appointment. Mr. Bringman was formerly employed by Great Lakes Steel Corp. as a practice engineer in masonry from 1957–60. From 1951–57 he advanced from trainee to hot strip mill foreman at Ford Motor Co.'s Steel Division.

A. D. Fentzke was appointed product manager, technical sales, Refractories Division of The Babcock & Wilcox Co. Mr. Fentzke, who joined the B&W Refractories Division in 1951, was formerly assistant laboratory manager of the division's Technical Department. He has also served as staff assistant in the department and as a development engineer.

Leslie J. Carson has been appointed director of engineering for Link-Belt Co. with headquarters at the executive office in Chicago. He will work with **Richard F. Bergmann,** vice president for engineering. Mr. Carson has been with the company since 1934, and since 1952 he has been general manager of Link-Belt's plant in Colmar, Pa. **Roderick S. Galloway** has been appointed general manager of the Colmar plant to succeed Mr. Carson. Mr. Galloway joined Link-Belt in 1928 and has been general manager of the Atlanta, Ga., plant and Link-Belt's southeastern division since 1945. **John M. Shepard, Jr.,** has been appointed general manager of the Atlanta plant and the Link-Belt southeastern division, succeeding Mr. Galloway. Mr. Shepard joined the company in 1946 and has been the chief engineer of the Link-Belt plant in Houston, Tex., since 1959.

Robert G. Hill has been named vice president of sales of the Leece-Neville Co. He has been with the company since 1941 in a wide variety of positions beginning in the Assembly Department and including work in engineering, technical service and sales. He was named manager of OEM sales in 1954, and was named general sales manager earlier this year.

Jack H. Bernstein has been appointed general manager of CompuDyne Electronics, Inc., a subsidiary of CompuDyne Corp. He had been with the Stromberg-Carlson Division of General Dynamics where he was production superintendent.

George D. Pfaffmann was named manager of the Michigan district for TOCCO Division of The Ohio Crankshaft Co. In addition to application engineering, sales and service, Mr. Pfaffmann will assume over-all supervision of the induction heating laboratory. He joined TOCCO in 1952 as an application engineer with the firm, and was successively promoted to commercial engineer, district engineer and engineering representative for the Michigan territory.

Arthur F. Uhrlandt was named to a newly-created position of director—marketing, Crouse-Hinds Co. He has been with the company 19 years. **F. William Oberle,** formerly divisional manager for the company's

(*Please turn to page 233*)

SUPERTHERM*

Centrifugally cast for 2300F

End Product is longer life and lower maintenance for heat-resistant parts . . . radiant tubes, furnace rolls, blowpipes, gas generators and other tubular or tubular-section components.

Supertherm* is a 26% Cr—35% Ni alloy strengthened and stabilized with cobalt and tungsten. Supertherm* has proved its capability within the 1800-2300° F range and under very severe heat-cycling conditions. In many cases, the alloy has extended service life two to three times over previous operations.

The uniformity, density, quality advantages of centrifugal casting are assured in full at Electro-Alloys, recognized as having one of the finest centrifugal-cast facilities in the country.

For further information on Supertherm* and its applications, contact your nearest Electro-Alloys representative. Or write to Electro-Alloys, and a technical bulletin will be forwarded to you.

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Supertherm alloy (trademark)

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION • Elyria, Ohio

Injection tuyeres contribute to improved blast-furnace performance

NBD reports on tuyere designs that simplify gas injection

Extensive research by iron producers the world over has firmly established the benefits of fuel and steam injection: higher blast temperatures, reduced coke requirements, increased tonnage and lower iron costs. And the tuyere, for decades a vital part of the blast furnace, is now assuming the additional function of an injection device.

Cooperating with blast-furnace operators, NBD product engineers are contributing to successful, simplified injection practices. An example is the sectioned tuyere pictured here which offers these distinct advantages:

1. The injection-tube feature may be incorporated in the basic tuyere design used in any furnace, whether the tuyere is a Standard, Angle Flow, Weir, Tennessee, or other design.

2. It serves a dual purpose in that it may be used in all tuyere locations in the furnace—and operated at will, with or without gas injection. Tuyere inventories are held to a minimum.

3. No expensive special equipment, such as lances or redesigned blow pipes and coolers, is required—just simple piping.

4. No exposed lances, nozzles or pipes, subject to damage by slag or metal splash.

An NBD sales engineer is prepared to give you more information specific to your application. Call him or write us.

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NATIONAL BEARING DIVISION
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Our Business is ANALYSES!

Shown in an organizational meeting of our Department Heads are: (left to right) T. J. O'Donnell, Chief Chemist; W. S. Bates, V. P. in charge of Sales; Mrs. S. J. King, Chief Spectrographer; Arno Tuteur, Laboratory Director; E. M. DuBois, President.

MEETINGS SUCH AS THESE . . .

coordinate our services to guarantee reliable analyses to our customers. Spectrochemical's facilities and personnel are at your command, ready to fulfill your analytical requirements.

Spectrochemical Laboratories, Inc. can act as another department of your company . . . ready to work for you upon request.

Our facilities enable us to accomplish many analyses which may not be practical in your present laboratory. We welcome the opportunity to serve you . . . and to say . . .

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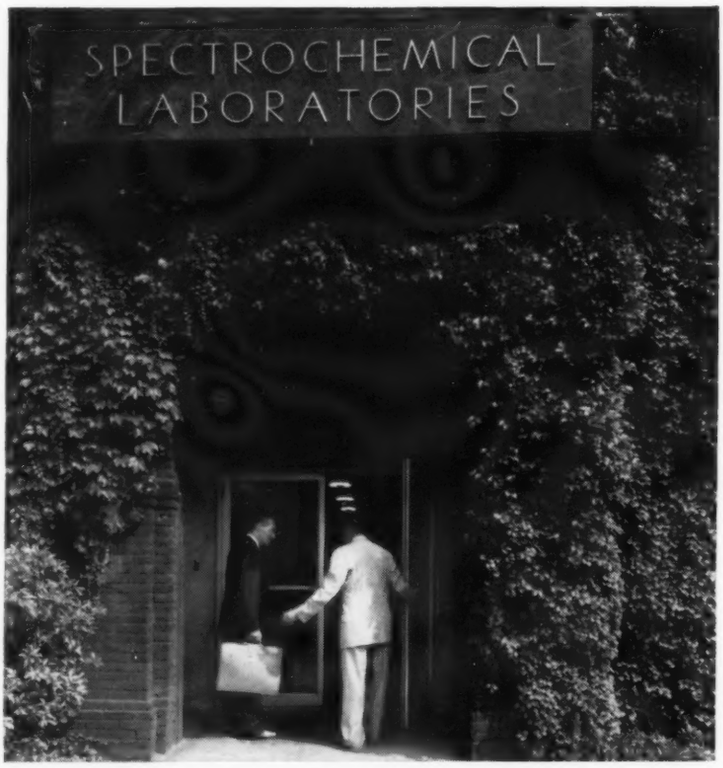

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SPECTROCHEMICAL LABORATORIES, INC.
P. O. Box 8781, Pittsburgh 21, Pa.

(*Continued from page 228*)

Northeast Division headquartered in New York City, succeeds Mr. Uhrlandt to the position of director—sales. **Gordon V. Miller,** formerly divisional manager, Atlantic Division, with headquarters located in Philadelphia, Pa., moves to the company's Northeast Division in New York City.

H. O. Douglas Jones has been appointed general mechanical foreman for the rod mill of The Colorado Fuel and Iron Corp.'s Pueblo plant. Mr. Jones has been serving as foreman of the scale, hydraulic and pneumatic shop since 1956, having worked previously as assistant mechanical foreman in the seamless tube mill. He joined CF&I in 1953 as an industrial engineer at the Pueblo plant.

Earle G. Benson was elected president of A. J. Boynton and Co., succeeding the late **Arthur J. Boynton,** founder of the firm. Mr. Benson has been associated with the firm since 1942, and was elected vice president in 1949. In 1960 he was elected executive vice president, and has been the chief administrative officer of the firm since being elected to the vice presidency. **J. B. Eberlein** and **J. H. Greenberg** were elected to two newly-created posts of vice president.

J. A. Lombardi has been named engineer—sales with the National Alloy Division of Blaw-Knox Co. He was formerly a project engineer for Swindell-Dressler Corp. and a line engineer in General Electric Co.'s Industrial Heating Department.

Earle W. Pitt has been named western field sales manager of The Foxboro Co. Also announced were the appointments of **Earl M. Kelly** as regional manager of the Cleveland territory and **Steve V. Kerstner** as branch manager of the company's Los Angeles office. Mr. Pitt first joined Foxboro in 1948 as a sales engineer in the Dallas office. In 1951, he was appointed manager of the office in Shreveport, La., and in 1955 became branch manager at Los Angeles. Mr. Kelly, formerly assistant regional manager of the Cleveland territory, replaced **Harvey L. Lee** who died recently. Mr. Kelly joined Foxboro in 1953 as a sales engineer in Chicago, transferring to the Detroit office in 1955 as assistant branch manager. He was named manager at Detroit in 1956 and assistant manager of the Cleveland region in 1960. Mr. Kerstner for the past six years has been a sales engineer with the Los Angeles branch.

Joseph J. Wilks, Jr., has been appointed superintendent of machine shops at Mesta Machine Co. Mr. Wilks was employed by Mesta in 1949 as an apprentice machinist and in 1956 was made assistant to the general superintendent. Four years later he was appointed machine shop foreman. Mr. Wilks succeeds **Max M. Kraus,** who is retired after being with Mesta since 1913. Mr. Kraus started his career with the company as an inspector and held various positions at Mesta. In 1945 he was made superintendent of machine shops, the position he held until his retirement.

John S. Tonetti has been promoted to assistant manager, gas turbine sales, for The Copper-Bessemer Corp. Mr. Tonetti joined Cooper-Bessemer in 1957 as an engineer in training. He was a test engineer in the company's Experimental Department in 1958–59. In 1959 he was promoted to design engineer for gas turbines in the Development Division of the Engineering Department, a position he held until his recent appointment.

Dr. Frederick D. Ezekiel has been named general manager of American Measurement and Control Inc., a subsidiary of CompuDyne Corp. He formerly was director of research for AM&C. Dr. Ezekiel succeeds **Donald G. O'Brien,** who remains as a consultant and as a director of CompuDyne.

James A. Brosovic has been appointed district sales manager, central region, for TRW Computers Co., a division of Thompson Ramo Wooldridge Inc. Formerly an applications engineer for TRW, Mr. Brosovic will be located at the company's central region headquarters, Chicago, Ill. Prior to joining TRW in 1960, he was section chief of the electromechanical research center at Republic Steel Corp.

R. E. Goodwill was appointed sales manager, Allis-Chalmers Manufacturing Co.'s Norwood, Ohio, works Electrical Department, succeeding **J. F. Fenske** who becomes manager, motor sales, Pacific region. Mr. Goodwill had been manager, Industrial Equipment Division, sales, Central region, since 1959 with headquarters in Cleveland. He has been with Allis-Chalmers since 1954. Mr. Fenske was manager of industrial sales in the Norwood works Electrical Department before

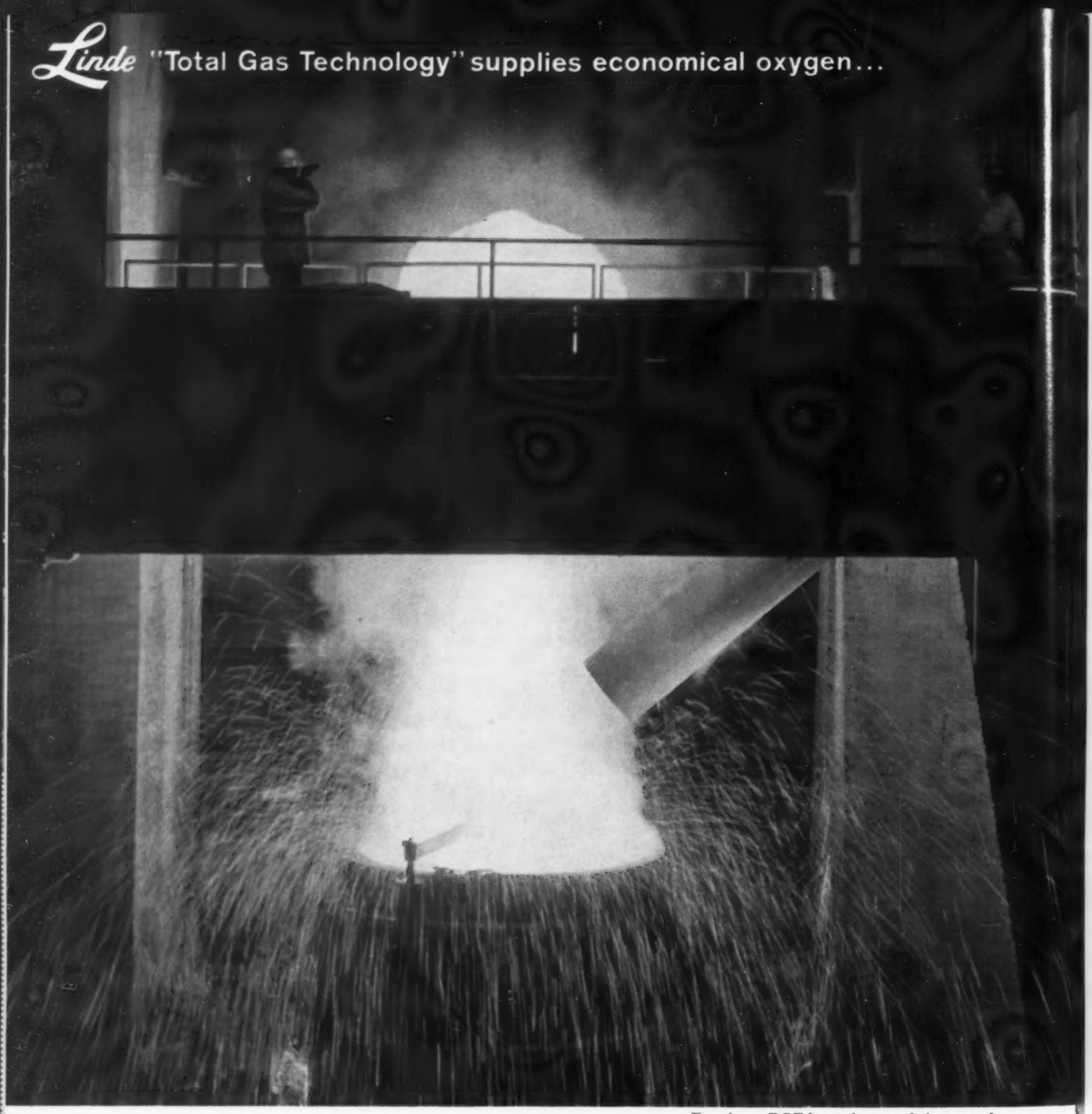
H. O. D. JONES

E. G. BENSON

J. B. EBERLEIN

J. H. GREENBERG

Linde "Total Gas Technology" supplies economical oxygen...



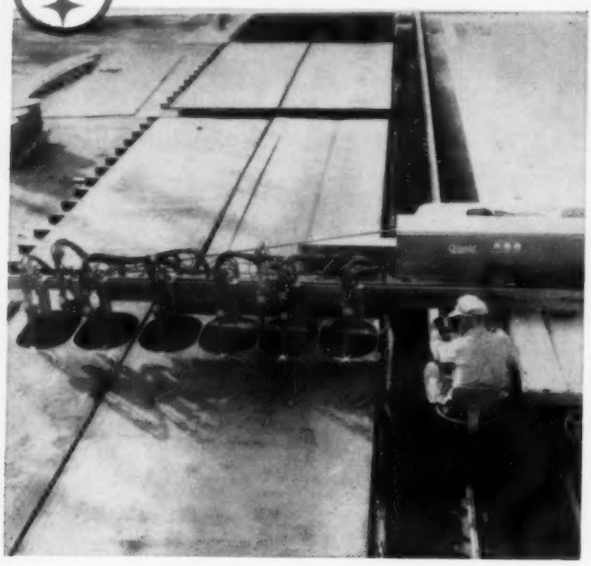
Pouring a BOP heat that used six tons of oxygen.

OXYGEN DOESN'T COST—IT

Every LINDE oxygen customer uses oxygen to save money. In some cases, this is a potential of as much as $4 an ingot ton in the steel-making furnaces alone. ✦ And LINDE's liquid oxygen system can supply supplemental oxygen—for peaks of demand, or full-scale tests—in tonnage quantities. A LINDE-supplied mill doesn't have to wait for a new oxygen plant to start using a new process. ✦ "Total Gas Technology" means more than economical oxygen. New processes, equipment, services are combining to lower production *and* fabricating costs, thus helping to sell steel. *Note two more examples at right.*

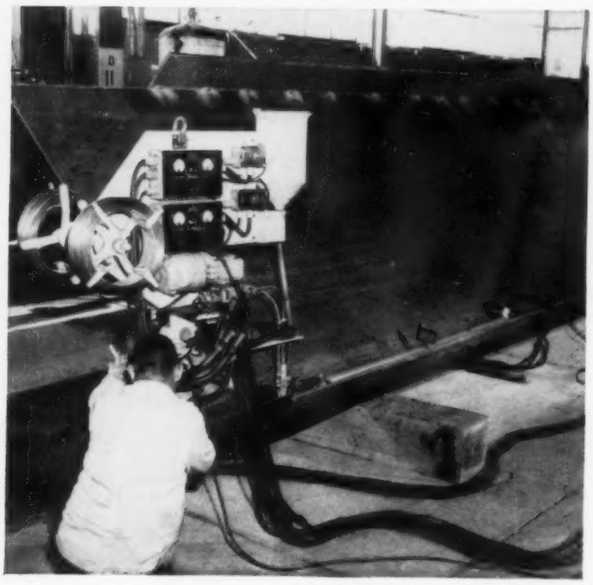
"LINDE," "UNION CARBIDE," AND "UNIONMELT" ARE REGISTERED TRADE MARKS OF UNION CARBIDE CORPORATION, AND USED BY ITS DIVISION, LINDE COMPANY, 270 PARK AVE., N. Y. 17.

Steel costs lowered by modern technology



New LINDE CM-60 automatic shape-cutting machine. Get top duty cycle and precision cutting of intricate steel parts–directly from line drawings.

Dual electrode UNIONMELT welding speeds attachment of stiffeners in making railroad gondola cars, reducing steel fabricating costs.



PAYS

LINDE COMPANY

UNION CARBIDE

A. B. FISHER, JR.

H. H. DINNEEN

being named manager of the sales department last year. He joined Allis-Chalmers in 1948.

A. B. Fisher, Jr., has been appointed chief engineer of the Engineering and Construction Division of Koppers Co., Inc. He has over 35 years of experience with Koppers and recently completed a major assignment on an overseas project. As chief engineer, Mr. Fisher will exercise general supervision of engineering design and specifications for industrial plants and equipment.

H. Hayward Dinneen has been named general manager of Rust Furnace Co., replacing **Frank A. Blaine** who has resigned. Mr. Dinneen has been chief engineer of the company since 1951.

Howard L. Sullivan has been promoted from distributor sales supervisor to assistant sales manager, Parker Fittings & Hose Division, Parker Hannifin Corp. Mr. Sullivan joined Parker in 1955.

Charles R. Cox has been appointed manager of the Pittsburgh district office of Dravo Corp.'s Machinery Sales Department. For the past 17 months Mr. Cox has been a sales representative for Union Barge Line Corp., a Dravo subsidiary. Prior to that he was assistant manager of the Machinery Sales Department's Pittsburgh district office.

J. Mylan Harvey has been named manager of the new Cleveland district office of Hagan Chemicals & Controls, Inc. Hagan had formerly been represented in the Cleveland territory by the Charles H. Tate Co.

C. R. COX

J. M. HARVEY

Mr. Tate will continue as sales and administrative consultant on special assignment. Prior to his appointment as manager, Mr. Harvey had been a sales engineer with the Charles H. Tate Co.

Cecil DeLange, a former sales trainee, has been appointed to the Chicago district office of Whiting Corp. At the same time, **J. S. Deacon,** formerly of the Schneible Co., joined Whiting. He will work from the Chicago sales office, specializing in foundry product sales.

John J. Vett has been named assistant manager of service engineering at The Youngstown Sheet and Tube Co. He previously was assistant superintendent of the Struthers rod and wire mill. He first worked for the company's Brier Hill plant in 1942. He became an observer in the seamless laboratory at the Campbell works in 1948, and then was named a junior investigator. In 1952 he became an assistant metallurgist. He was assigned to the Detroit district sales office in 1954 as a service engineer. Soon after he returned to Youngstown in 1959 he was named to the rod and wire mill post.

A. M. Andrews, Jr., has been appointed president of Airco Co. International. He succeeds **J. G. Bell,** who is retiring. Mr. Andrews started in the Export Department of Air Reduction Sales Co. in 1944. When the department was formed into a separate division in 1945, he was appointed an assistant to the vice-president in charge of sales. Four years later he became sales manager, a position he held until his most recent promotion.

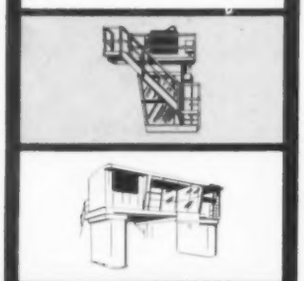
Stanley G. Wells has been named manager of the Chicago district office for the Welding Products Division of Harnischfeger Corp. Mr. Wells has been with Harnischfeger since 1957, principally in the firm's Cleveland office.

Obituaries

Edwin F. Neuman, manager of service for Automatic Transportation Co., Division of The Yale and Towne Manufacturing Co., died October 11.

John W. Sheffer, former general improvement engineer, American Car & Foundry Co., died October 10. Mr. Sheffer, a life member of the AISE, retired in 1951.

LINTERN



The Standard in Air Conditioning for Crane Cabs and Mill Pulpits
Over 2,500 Installations
Performance Guaranteed
Ask for Booklet AC-573

Larco, inc.

DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS
ROUTE 20 EAST • PAINESVILLE, OHIO

NEW NEW NEW NEW NEW NEW NEW NEW NEW

when it MELTS you know the *temperature!*

NEW *Markal* THERMOMELT TEMPERATURE INDICATORS

With Handy Adjustable Holder

The easy modern way to determine exact working temperatures!

Just mark or stroke the surface with THERMOMELT . . . when it reaches the desired temperature, the mark liquefies. There's no guesswork, no wasted time or material . . . THERMOMELT is the quick, precise way to determine heating temperatures. Accurate to within ±1%.

A Stik For Every Temperature from 113° F. to 2000° F.

SEND TODAY for free THERMOMELT literature and pellet sample (indicate temperature desired).

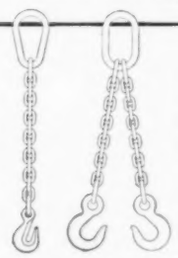
ALSO AVAILABLE IN LIQUIDS AND PELLETS for inaccessible or hard-to-measure applications. Wide range of temperatures.

Made by the Manufacturers of Markal Paintstik Markers and Protective Coatings.

MARKAL CO. 3087 West Carroll Avenue • Chicago 12, Illinois

HERC-ALLOY

The Original Alloy Chain



● Has many superior features—is lighter, therefore easier to handle...is long wearing...has high resistance to impact loading...is Inswell welded. Chain and all fittings are 125,000 p.s.i. tensile strength alloy steel.

● Write for Bulletin 100 covering Herc-Alloy Sling Chains, including helpful information on their care, use and inspection.

● Sold in running lengths, slings assembled to customers' specifications and other special assemblies.

RUGGED • DURABLE CM® CHAIN

COLUMBUS McKINNON CHAIN DIVISION
COLUMBUS McKINNON CORPORATION
TONAWANDA, NEW YORK
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CHICAGO • SAN FRANCISCO (Factory Branch)
In Canada: Columbus McKinnon Limited, St. Catharines, Ontario
HERC-ALLOY®

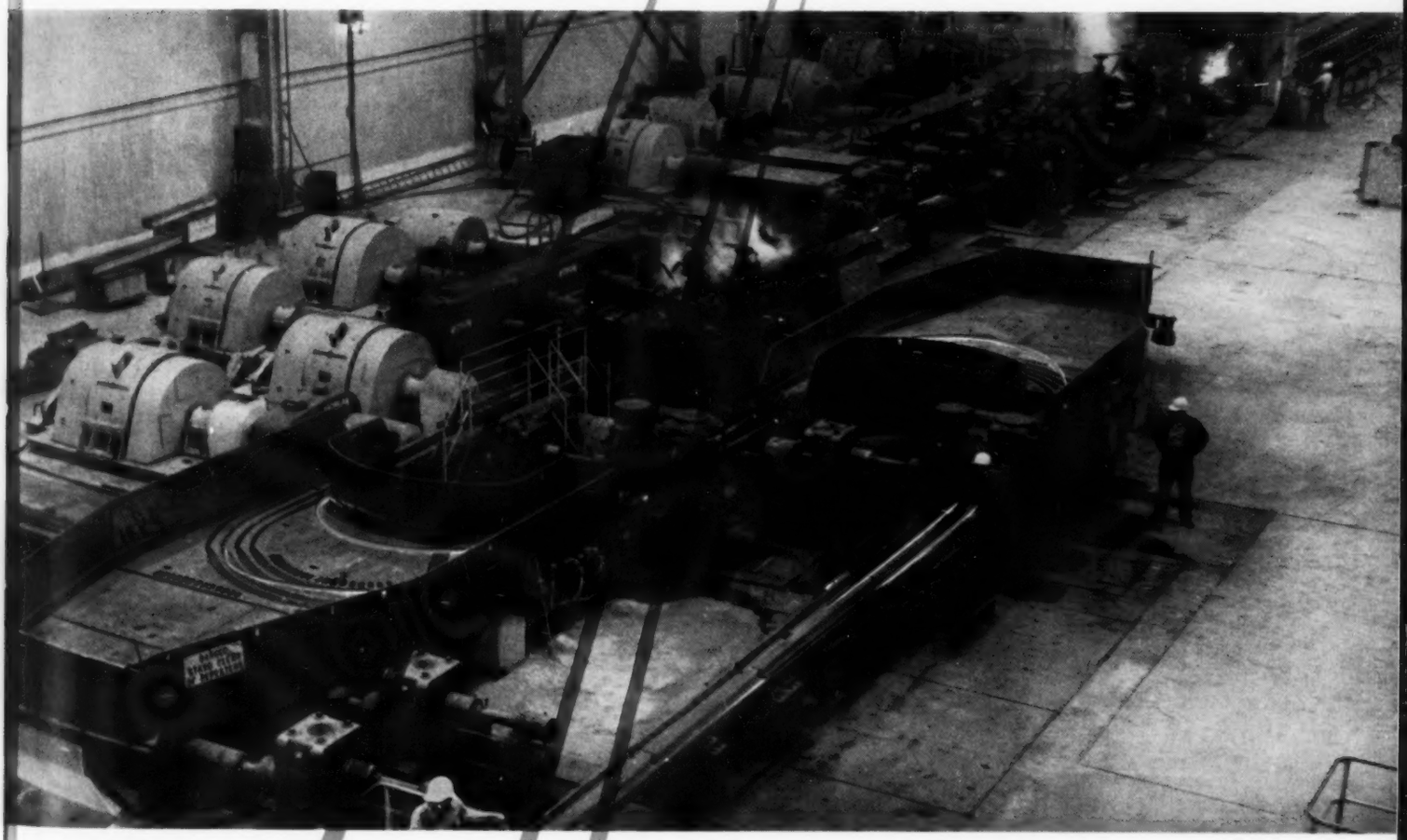
MORGAN MILL FAST INCREASES BETHLEHEM'S RE-BAR CAPACITY

HIGH SPEEDS BOOST BAR PRODUCTION

ADAPTABLE FOR SIZE CHANGE AND SPECIAL CUT-OFF

ELECTRONIC CONTROLS MAINTAIN UNIFORM QUALITY

Deformed, concrete reinforcing bar is being turned out at the rate of 2600 f.p.m. in Bethlehem Steel Company's new Bar Mill at Steelton, Pa. This new, fully automatic, double strand Morgan mill can produce a five-ton bundle of No. 3 bars every 10½ minutes—operating data which underscore Morgan's world-recognized engineering ability to design mills that meet the current market demand.



MORGAN WORCESTER

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

ROLLING MILLS • MORGOIL BEARINGS • WIRE DRAWING MACHINES • COMBUSTION CONTROLS

Don't get boxed in by oxygen supply problems...

Keep your steel operations flexible by removing all uncertainties about oxygen supply with an Airco tonnage oxygen plant. A plant we build and operate for you — on or adjacent to your site — gives you assurance of supply that only an experienced oxygen producer like Airco can guarantee.

GUARANTEED BACK-UP. Your oxygen plant is backed up by Airco's nationwide network of oxygen plants. If the plant is down for any reason, Airco will keep your oxygen flowing from its integrated system. If you need more oxygen than originally anticipated, Airco will supply whatever quantities you require. And you won't be boxed in with a rigid purchase arrangement that can't be adjusted to steel production.

PROVEN TECHNOLOGY. Making oxygen — like making steel — is a specialized business. Airco has 45 years'

let Airco build and operate a plant for you

experience in low-temperature technology . . . design, engineering and construction proficiency that has dotted the country with oxygen plants — including the first on-site oxygen plant for steel. There's no first-plant guesswork . . . late starts . . . long debugging periods that ruin your production schedules.

ASSURED LOW COST. Your oxygen is available fast . . . at a firm, fair price that reflects the economies provided by Airco's large resources and long experience

For the full oxygen story, write, wire or phone today.

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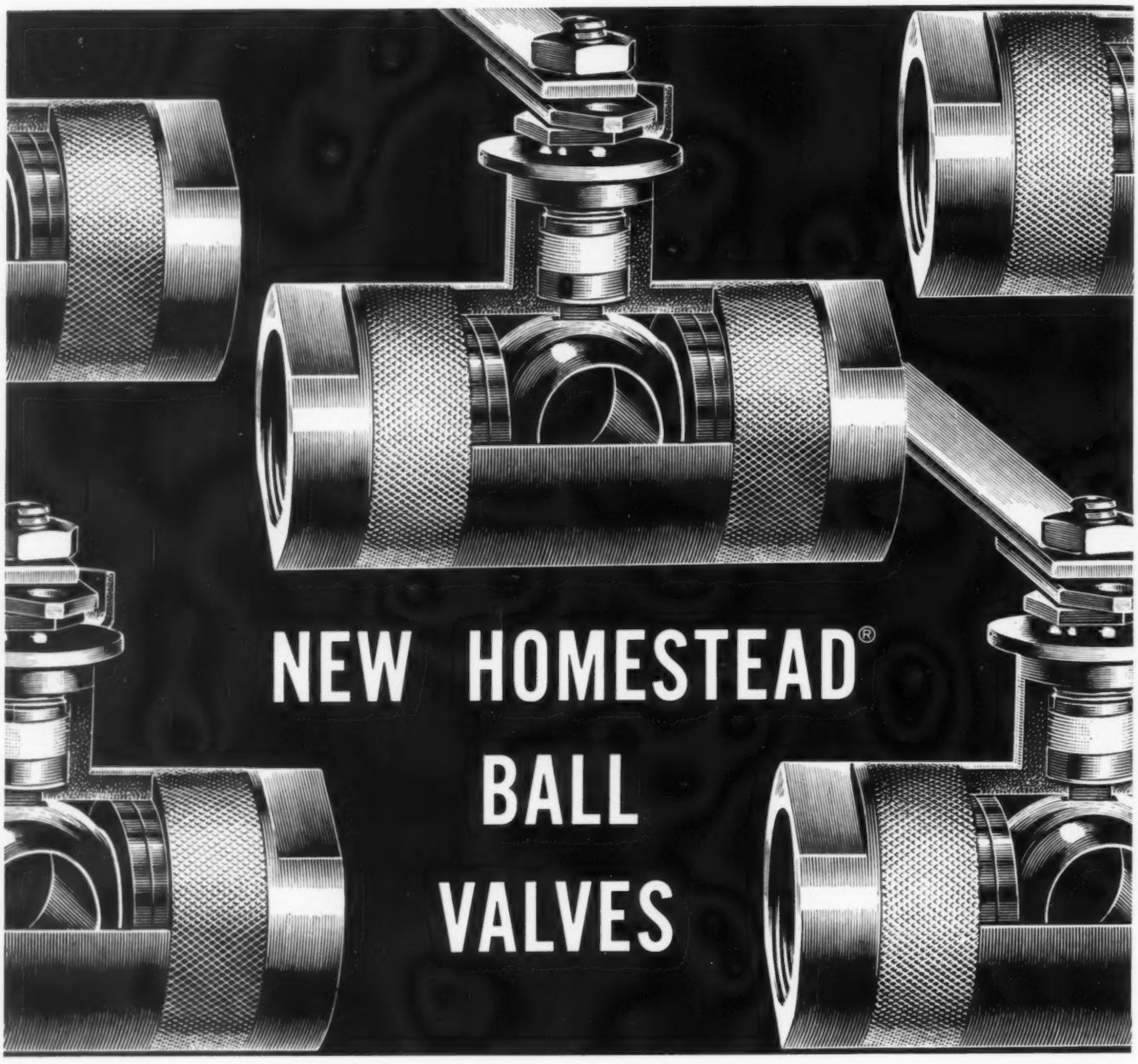


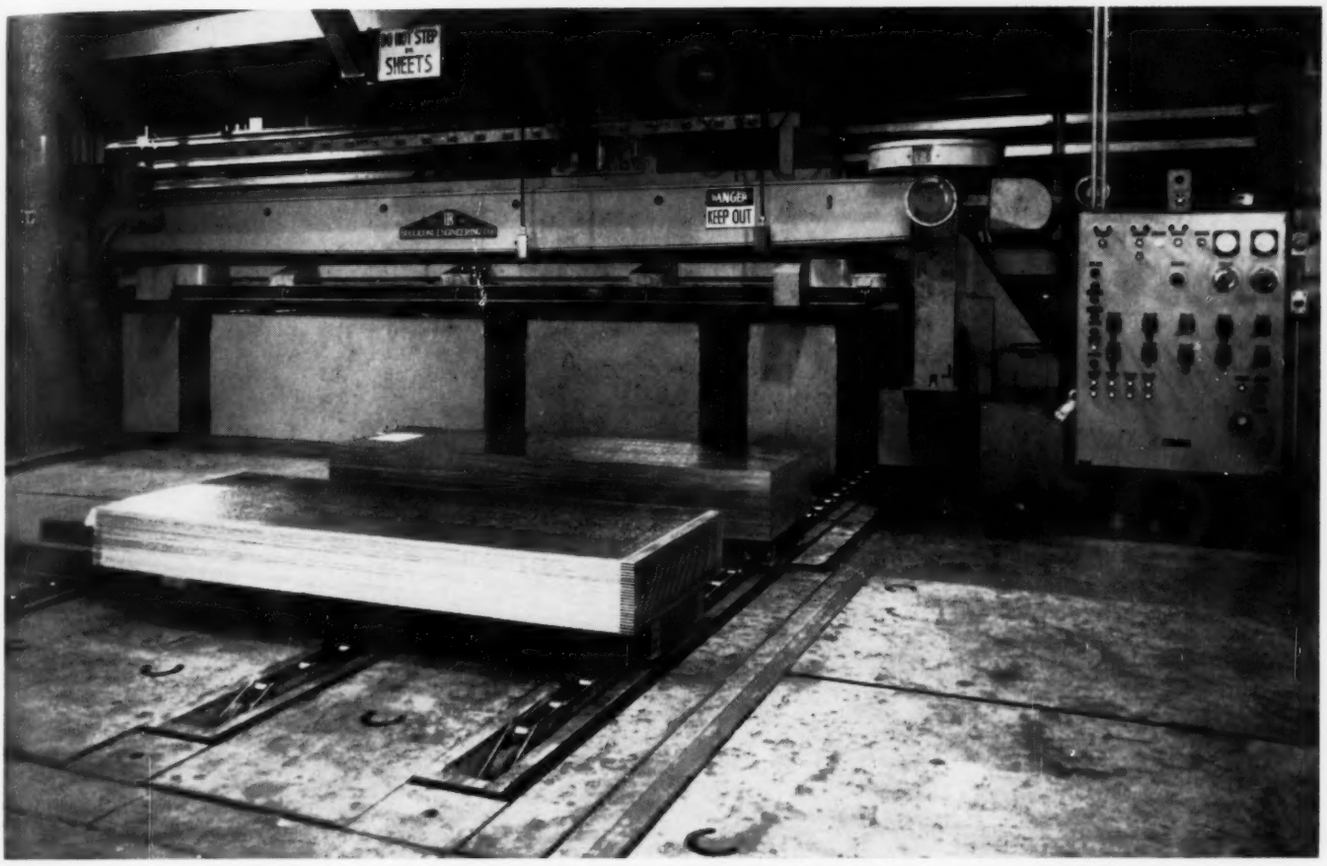
gain immediate industry approval

Recently introduced as the newest member of the growing family of Homestead Valves, the new Ball Valve has earned its Homestead name. Investigate and you'll discover why. No corrosion problem, because Homestead Valve engineers chose the right combinations of seals and metals for almost any fluid in the world. No leakage problem, because the self-adjusting ball and flexible seals put a positive stop to fluid flow when valve is installed in either direction . . . also Teflon barrel packing and metal shoulder prevent ball from being forced downward. No operating problems either, because an easy quarter-turn opens or closes valve; and an outside stop, plus flow direction indicator, show direction to turn. Homestead Ball Valves are offered in a choice of full pipe area or restricted flow patterns; and in either slip-out or bar-stock design. For complete facts write for Reference Book 39-5.

HOMESTEAD VALVE MANUFACTURING COMPANY
"Serving since 1892"
P.O. Box 160, Coraopolis, Pennsylvania

Makers of: Homestead Ball Valves, Cam-Seald, Lever-Seald and Lubricated Plug Valves

BUCCICONI MAGNETIC SHEET PILER ON YOUNGSTOWN'S NEW GALVANIZING LINE



Piler in operation at The Youngstown Sheet and Tube Company's Indiana Harbor Works.

FEATURES

1. 62″ x 264″ x 10 ga. cap.
2. Automatic sheet stagger piling device.
3. Side guide sheet catching fingers.
4. Automatic lift level controls.
5. Mechanism for moving side guides off the machine center line.
6. Electronic magnet supply and control.
7. Position adjustment for magnetic rails.
8. Improved magnetic conveyors.

Bucciconi pilers applied to continuous galvanizing lines offer many advantages due to a high degree of versatility and adaptability. Various features can be combined to suit your service requirements.

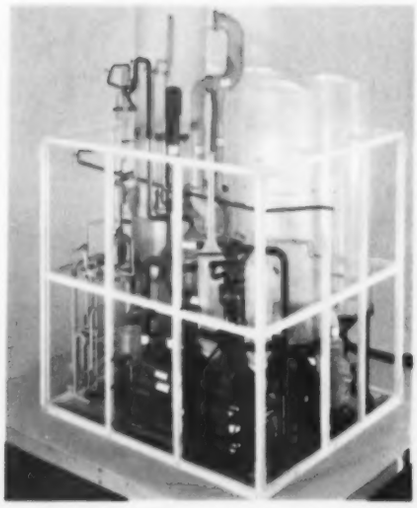
Send us your specifications . . . we will reply promptly, with literature or a quotation.

BUCCICONI ENGINEERING COMPANY INC.

PIONEERS AND MANUFACTURERS OF MAGNETIC AUTOMATION MACHINERY FOR HANDLING STEEL SHEET AND STRIP
MANUFACTURERS OF MAGNETIC CONVEYORS, MAGNETIC SHEET PILERS AND DE-PILERS, MAGNETIC ROLLS, MAGNETIC PROXIMITY INDUCTO-SWITCH, THE D. B. MICROGAGE, AND TIN PLATE ASSORTING EQUIPMENT.

899 GRANT STREET GARY, INDIANA U. S. A.

Reduces, Separates, Transports, H

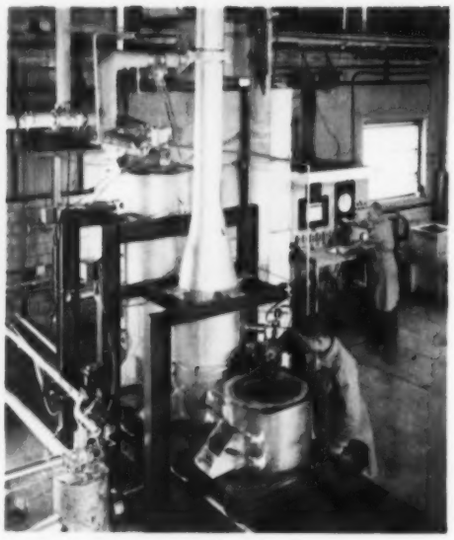


SEPARATES: Engineering model of cold box for a Dravo-Linde AG air separation plant. Highly efficient, these units produce oxygen at low cost. Dravo turn-key construction services also include power and steam plants, water pumping and treatment systems, piping, other plant installations. Check coupon for details.

TRANSPORTS: Union Barge Line, Dravo subsidiary, offers common carrier and contract transportation service to all points on the Mississippi River System and Gulf Intracoastal Waterway. Modern equipment, regularly scheduled sailings assure economical and reliable deliveries. For details, check and mail the coupon.

HANDLES: This giant multi-purpose dock handles incoming raw materials and outgoing products for major steel producer. Dravo pioneered cellular dock construction and has built them of all sizes for virtually every industry. For information on docks and Dravo bulk materials handling equipment, mail the coupon below.

HEATS: Eleven Dravo space heaters provide low-cost comfort heating in this fabricating plant. Over 20,000 units (250,000 to 2,500,000 btu) have been installed in many different types of buildings of all sizes. Check, mail coupon for information.



AGGLOMERATES: At Dravo Research Center, continuing studies are conducted to improve pelletizing, briquetting and sintering processes and plant design. For details on agglomeration or beneficiation processes, check and mail the coupon.

REDUCES: Stora-Kaldo basic oxygen steelmaking process offers high metallurgical control, heat economy and yield. Dravo designs and builds these plants in the U.S.A. and Canada.

Dravo Corporation, 4800 Grand Avenue, Pittsburgh 25, Pa.

Please send me information on the following products and services:

☐ Pumping Stations & Intakes	☐ Oxygen Steelmaking	☐ Steam & Power Plants
☐ Sewage & Water Treatment	☐ Ore Bridges	☐ Towboats & Barges
☐ Coal & Ore Unloaders	☐ Shafts, Slopes	☐ Fabricated Piping
☐ River Transportation	☐ Grating	☐ Container Cranes
☐ Sintering & Pelletizing Plants	☐ Space Heaters	☐ Compressor Stations
☐ Docks, Harbors, Foundations	☐ Oxygen Plants	☐ Process Machinery

Name_____ Title_____

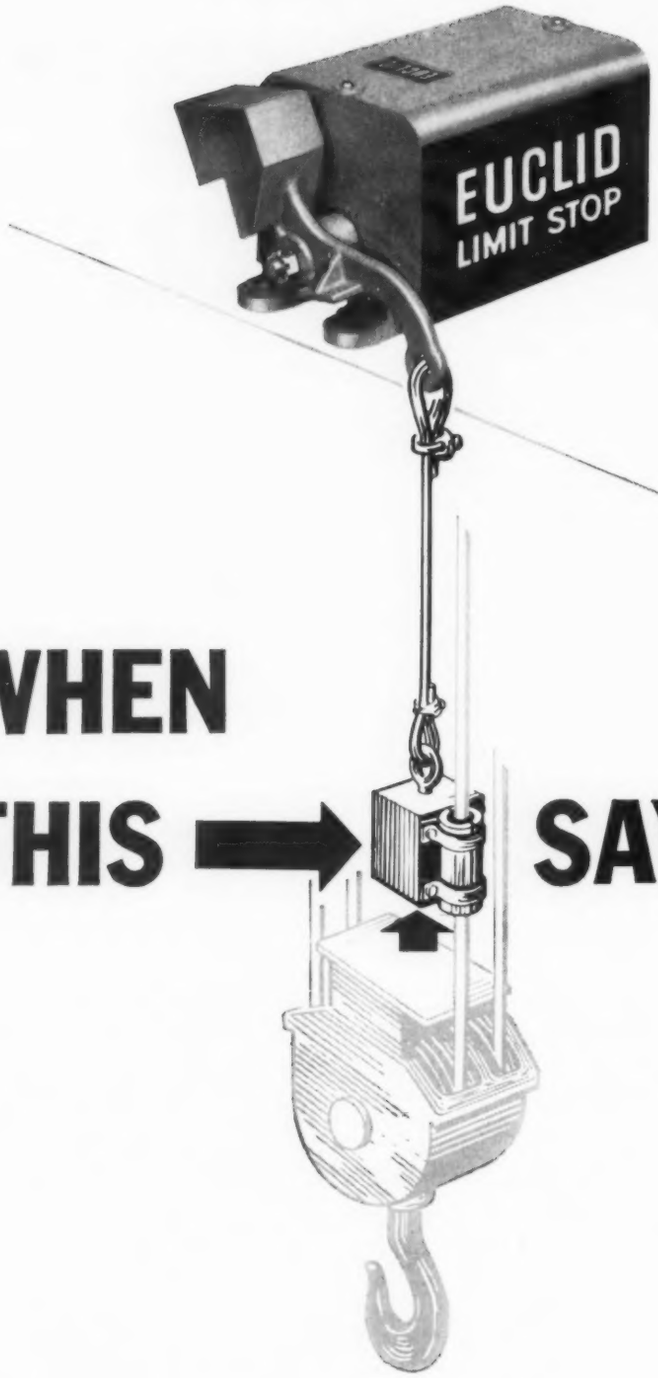
Company_____

Address_____

City_____ Zone_____ State_____

DRAVO

s, Handles, Heats, Agglomerates



WHEN THIS → SAYS STOP the Hook Block STOPS!

Safe

No danger of overhoisting disasters (particularly damage to the trolley frame or hoisting mechanism) when it's EUCLID.

Simple

Tripping and reset weights do the job. Positive trigger action is assured when it's EUCLID.

Sure

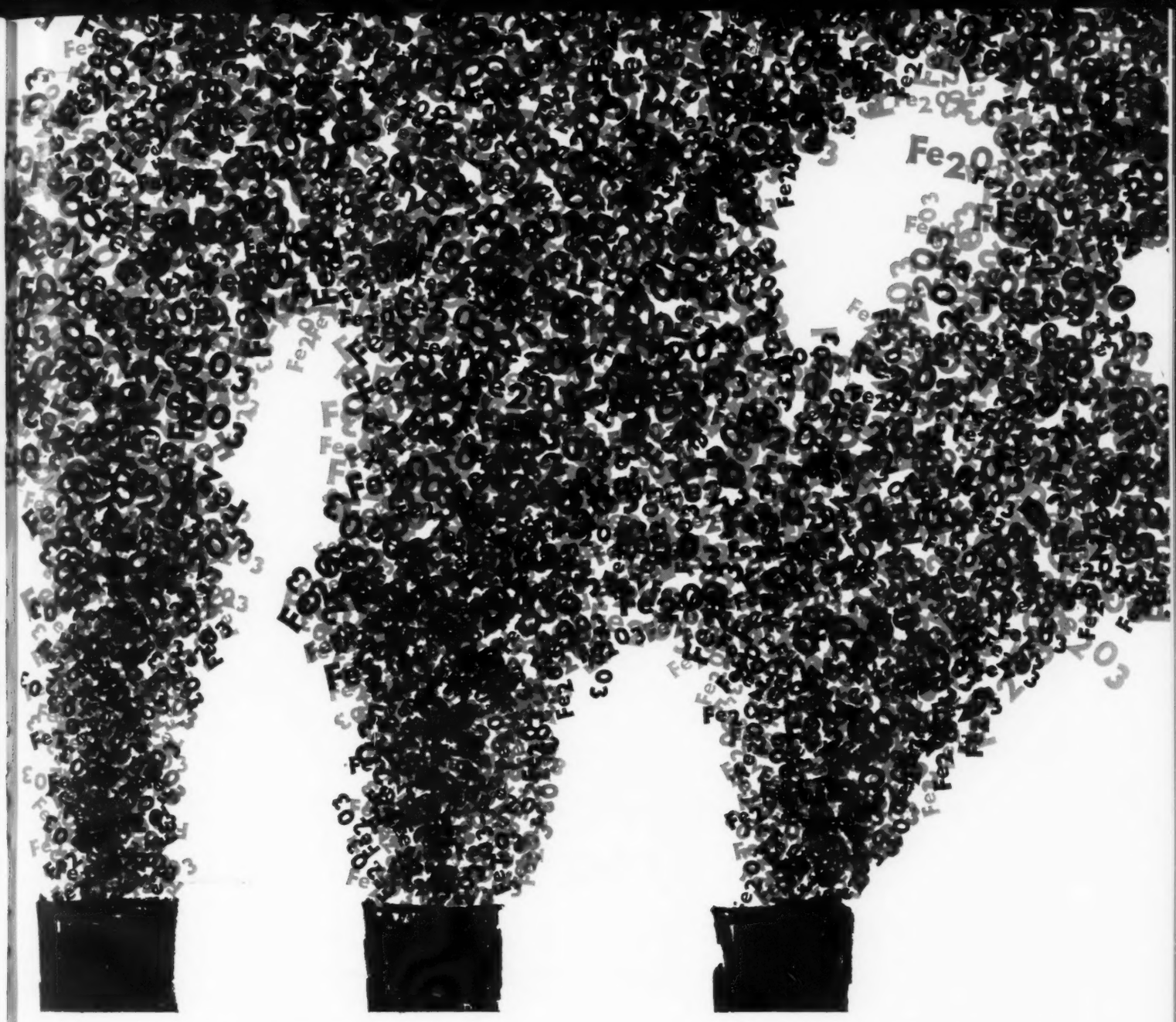
Because this Crane Power Safety Limit Stop is EUCLID designed, tested, engineered and field proved.

For more information about this heavy-duty, smaller in size, lighter in weight Limit Stop, ask for Bulletin 2130.

EX-28

We specialize in designing the control system best suited to your individual needs. Our services are yours for the asking. **CUSTOM ENGINEERING IS OUR BUSINESS. WHAT'S YOUR PROBLEM?**

The EUCLID Electric & Mfg. Co.
Dept. A • MADISON, OHIO



USING O_2 IN YOUR OPEN HEARTH? Chemico Venturi Scrubbers do more than simply solve the air polution problems brought on by the use of oxygen in steel making. Operating and performance figures indicate that for oxygen steel converters, oxygen lanced open hearth furnaces, electric furnaces and flame scarfing, the Chemico Venturi Scrubber solves those problems with higher efficiency and at lower cost than any other method now in operation. Specifically, these are the advantages of a Chemico Venturi Scrubbing System:

CAPITAL INVESTMENT—Chemico Venturi Scrubbers can be installed for approximately 30-50% less capital cost than required for electrostatic precipitators.

OPERATING AND MAINTENANCE COSTS—Chemico Venturi Scrubbers require so little maintenance and manpower, that over-all operating costs are dramatically lower than for other methods, even though power requirements may sometimes be slightly higher.

CONSISTENT PERFORMANCE—The Chemico Venturi Scrubber attains maximum cleaning efficiency at start-up. This peak efficiency is not decreased by subsequent changes in the gas flow or other variations in process conditions.

COLLECTION AND DISPOSAL—The Chemico Venturi Scrubber collects iron oxide dust wet and recovers it dry—free of contaminants and ready for re-use. It eliminates the common and very serious problem of how to handle and dispose of dry dust collected in an electrostatic precipitator.

WATER REQUIREMENTS—The Chemico closed cycle scrubbing process eliminates water disposal problems and cuts make-up water requirements to a minimum. Normally, no more than 50-100 GPM is needed.

PROCESS FLEXIBILITY—Adjustable Venturi throat permits automatic control of furnace draft while maintaining full cleaning efficiency.

If you are considering the installation of gas cleaning equipment, a Chemico representative would be pleased to discuss performance and cost figures with you. Chemico handles the complete job:

PLANNING—DESIGN—ENGINEERING—CONSTRUCTION and START-UP.

CHEMICO

Chemical Construction Corporation, Gas Scrubber Division, 320 Park Ave., New York 22, New York

Ferndale, Mich. Chicago, Ill. Los Angeles, Calif. Houston, Tex. Bartow, Fla. Birmingham, Ala. Pittsburgh, Pa.

DE LAVAL

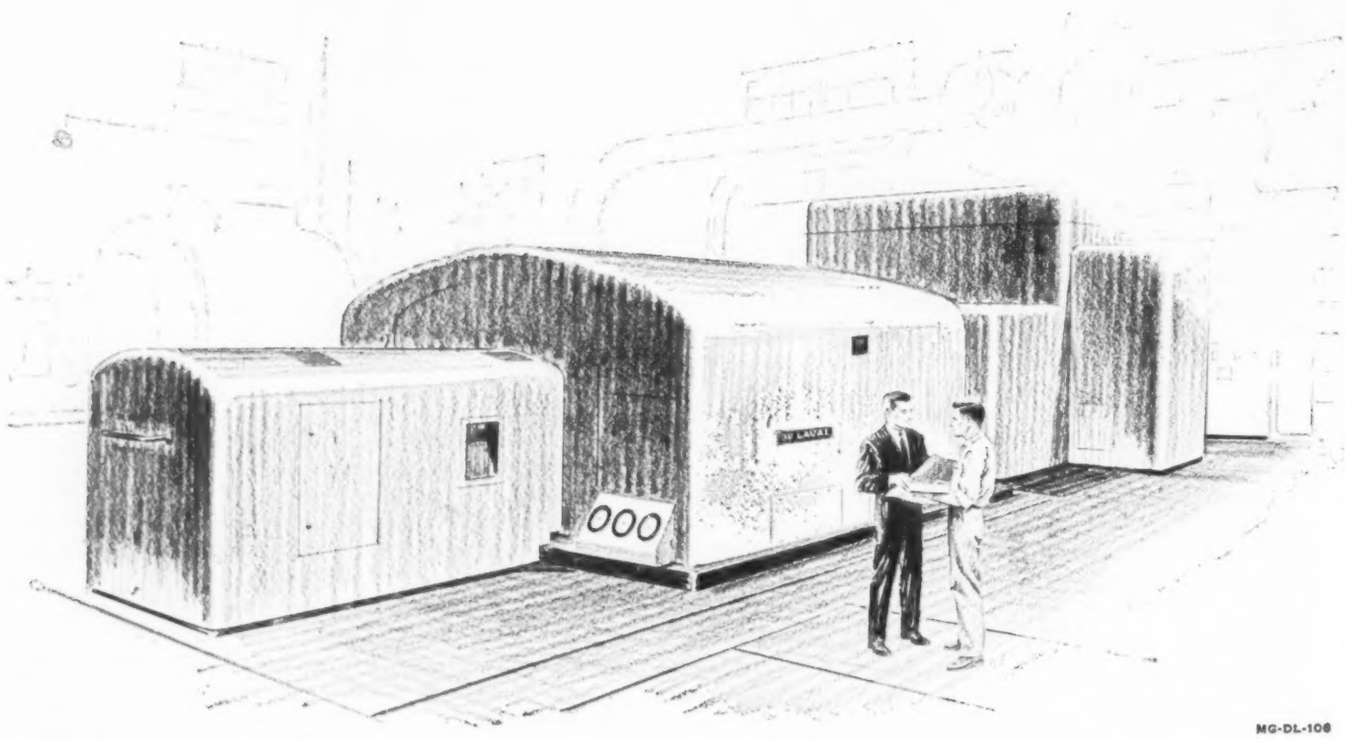
engineered flexibility lets a turbine "grow"

With his eye on tomorrow, a major food processor gave De Laval unusual requirements. He wanted a turbine that would meet today's power and process steam needs . . . and be capable of almost doubling its output in the future. The result: a De Laval turbine to which five additional stages can be added in the customer's plant.

Present capacity of this unit is 5,000 kilowatts which will be raised to 9,375. For future operations, steam pressure and temperature will also be sharply increased.

Whether you need a turbine that can "grow" or have other problems involving heavy rotating machinery, De Laval engineered flexibility can help.

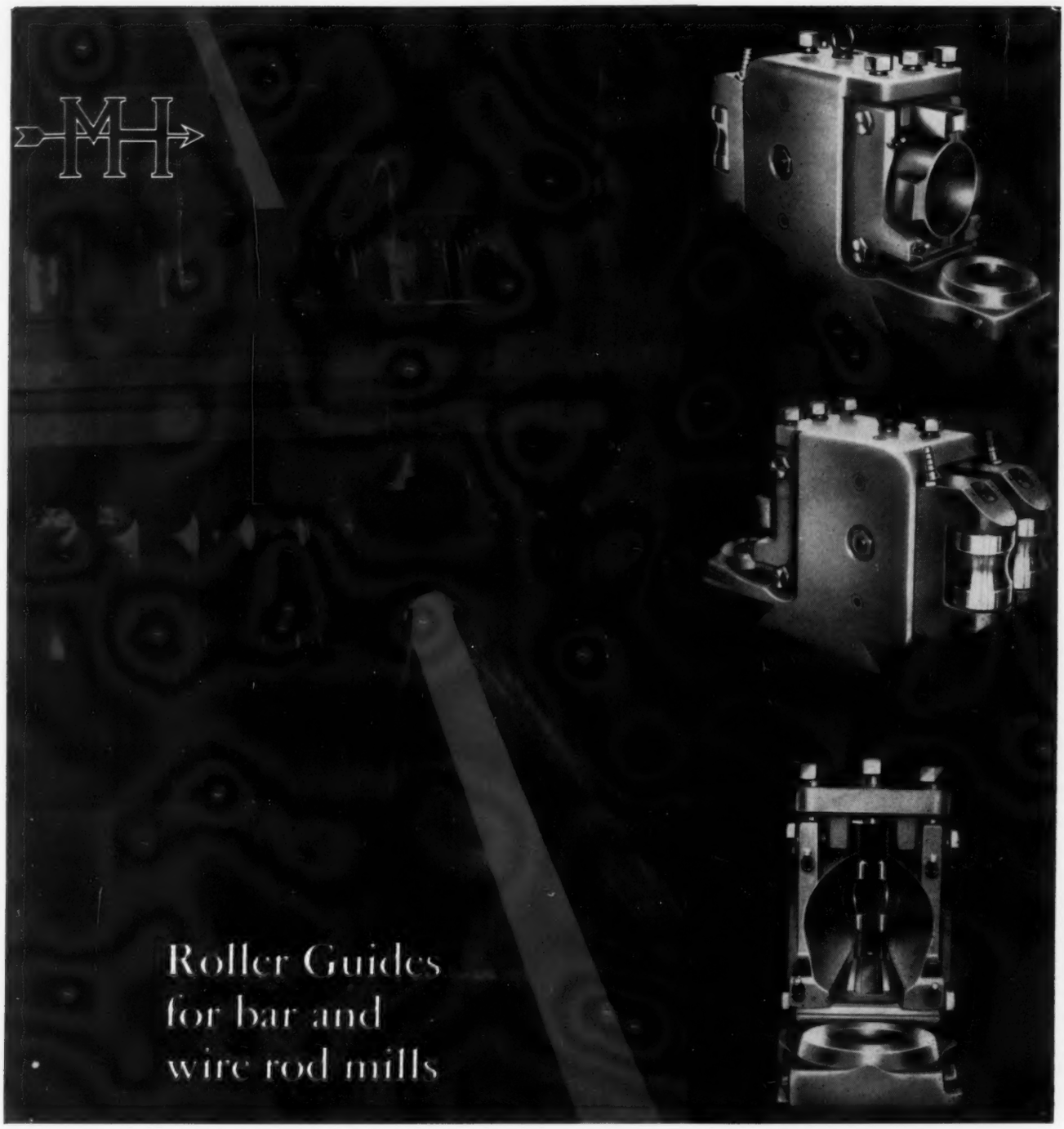
De Laval Steam Turbine Company, Trenton 2, N. J.



MG-DL-108

DE LAVAL · 60 YEARS OF CREATIVITY AND QUALITY

CENTRIFUGAL PUMPS AND COMPRESSORS • TURBINES • IMO® ROTARY PUMPS AND HYDRAULIC MOTORS
MARINE PROPULSION AND AUXILIARY EQUIPMENT • HELICAL AND EPICYCLIC GEARS • TURBOCHARGERS



Morgårdshammar roller guides can be used for many sections such as leader and break-down ovals, squares, hexagons and octagons.

They can handle dimensions from about 3/16 in. (5 mm) round up to nearly 8 in. (200 mm).

You will obtain the following advantages with MH roller guides:

- INCREASED ACCURACY
- LESS SCRAP AND COBBLES
- REDUCED OPERATING COSTS
- INCREASED OUTPUT

For further information please apply to us for catalogues.

P.S.
In Scandinavia every bar and wire rod mill uses Morgårdshammar roller guides.

Sole agent for the U.S.:
K. W. Atwater Engineering, Inc.
124 Grant Avenue
PITTSBURGH, Pa.

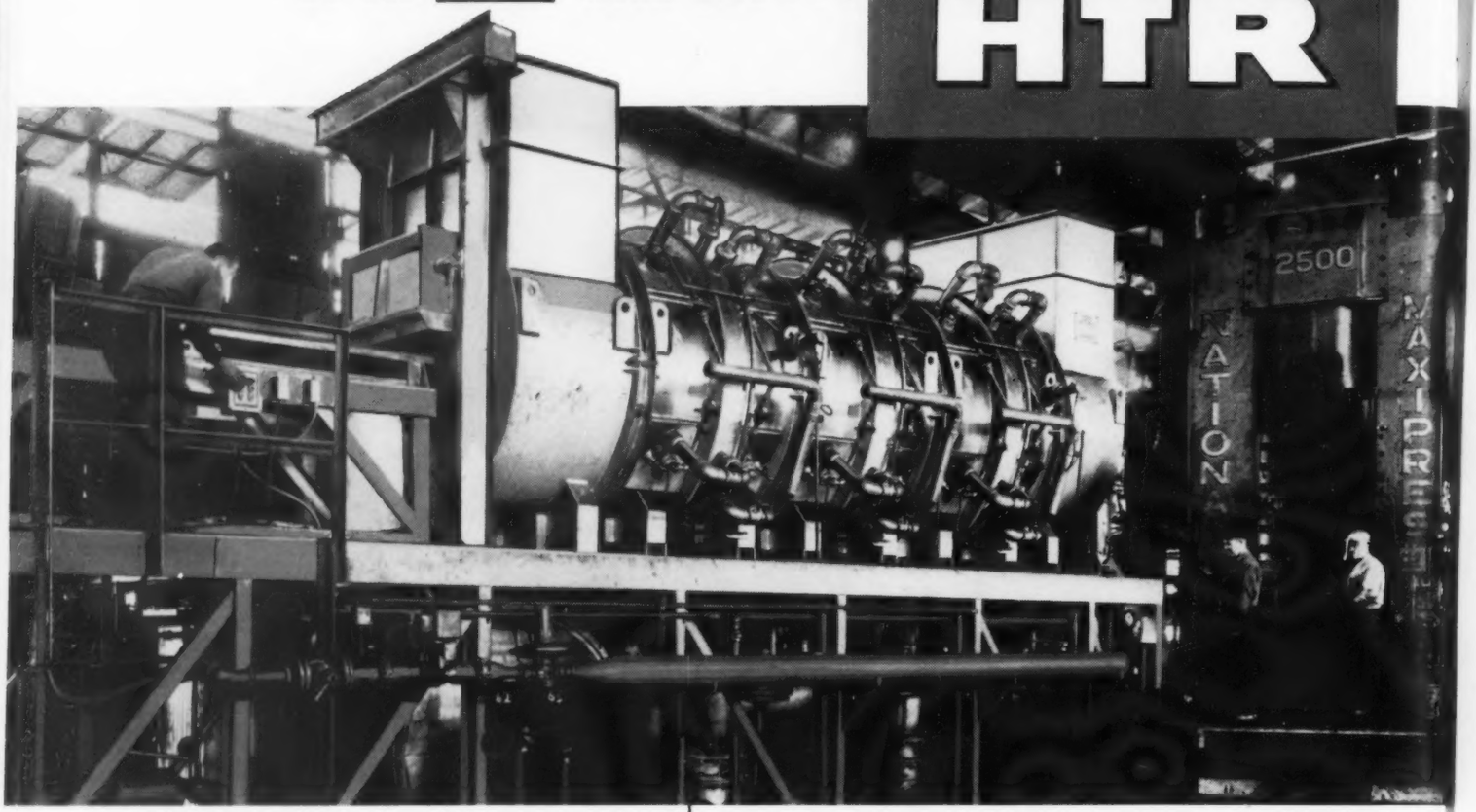
Swedish Quality

MORGÅRDSHAMMAR
MORGÅRDSHAMMARS MEK. VERKSTADS AB • MORGÅRDSHAMMAR

HIGH-SPEED HEATING

at its BEST with the . . .

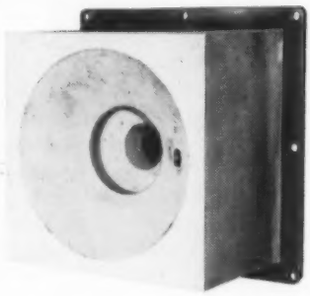
BLOOM HTR



Courtesy of Gas Machinery Co.

No metallic parts exposed to high temperature.

Contoured port block gives high temperature radiating surface with no forward flame velocity.



Bloom HTR Burners were selected by the furnace builder to fire this high speed pusher type forge furnace. High heat release without flame impingement on the product and adaptability to furnace shape made the HTR Burner ideal for the job. Here are the results:

OPERATION

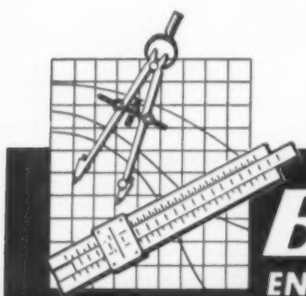
Material	4" cubes
Production rate	8000 lbs. per hour
Heating time	8 minutes—2 minutes per inch
Furnace temperature	2650°F
Scale condition	so light that no special scale removal equipment is needed.

MAINTENANCE

No furnace repairs } in first year
No burner or port block maintenance } of operation.

Other successful HTR Burner applications include:

Tube Upsetting
Continuous Strip Pre-Heating, Annealing, Coating, and Drying
Batch type Forging
Aluminum Chip Melting
Glass Melting



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

ENGINEERING EXPERIENCE EQUIPMENT

To Meet Customer Demands

New Side Trimming Line Installed In Tin Mill Will Improve Production Of Tinplate In Coils

Installation Called Most Modern Of Type In Industry

A new side trimming line to facilitate the production of tinplate in coils in Weirton Steel's Tin Mill Department was placed in operation recently.

W. H. Wright, Vice President and Chief Engineer, said the new installation, rated among the most modern pieces of equipment in the steel industry, was installed because of the increasing demand from customers for tinplate in coil form. The company will also continue to ship tinplate in the conventional cut sheets.

The new side trimming line, which began operating last month, and a second line, installed on an emergency basis, are used to trim the sides of the sheet steel before it is plated with tin, so it can be wound into coils and be ready for shipment as it comes off the tinning lines.

Mr. Wright explained that Weirton Steel's No. 4 and No. 5 tinplating lines have been equipped with edge control reels which insure that each coil is wrapped with a straight edge. This is necessary to prevent damage to the edges in bundling and shipping and also because straight edges are required when the coils are processed further by Weirton Steel customers.

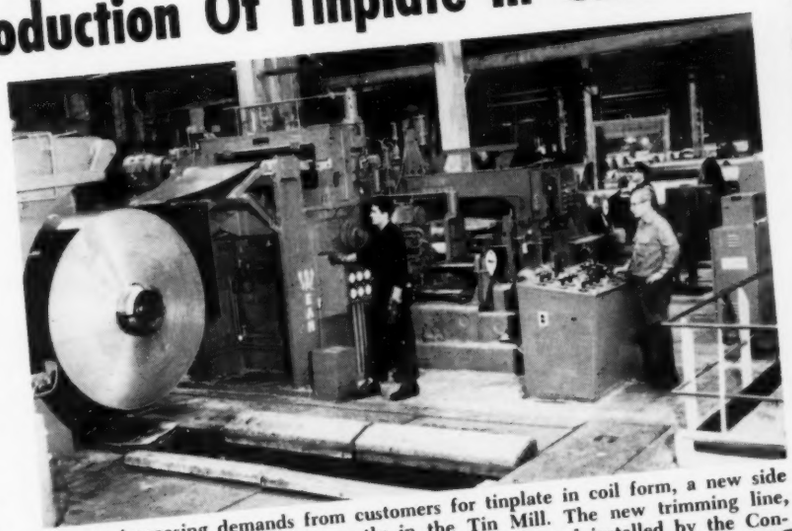
Mr. Wright also reported the installation of a new bundling line, which began operating about three months before the new side trimmer. The bundling line utilizes machinery to wrap coils in heavy paper and fasten them with steel straps. Formerly, this was a hand operation.

The side trimming operation takes place after the steel has been tempered to customer specification by the skin mills and before it is plated with tin. This process eliminates the waste which formerly resulted when the side trimming was done on the cutting lines, after the tinplating process.

The No. 2 side trimming line has a maximum speed of 4,000 feet per minute while the No. 1 line operates at a speed of 1,200 feet per minute. The No. 2 line is able to handle 30-ton coils 85 inches in diameter and 45 inches wide. The line also is equipped with a mash welder, a relatively new operation which provides a smoother weld that does not damage other sections of the coil as it is wound.

All of the new facilities were designed by the Weirton Steel Engineering Department and installed by the company's Construction Department.

Reprinted from Employees Bulletin, Weirton Steel Company, February, 1960



Due to increasing demands from customers for tinplate in coil form, a new side trimming line was installed recently in the Tin Mill. The new trimming line, designed by Weirton Steel's Engineering Department and installed by the Construction Department, [illegible] of sheet steel before it is plated with tin.

Once again—

proof that GPE Controls is the Steel Industry's "Partner In Progress"

The tin mill side trimming line at Weirton Steel Company, Division of National Steel Corp., was furnished by Wean Engineering Co., and equipped with the industry's most modern edge guide equipment—designed and built by GPE Controls, Inc.

Only GPE Controls offers steel mill edge guides with . . .

- ★ **Non-clogging sensing nozzles with lowest air consumption.**
- ★ **Unlimited force output with cylinder pressures to 2000 p.s.i., flows to 140 g.p.m and higher.**
- ★ **Variable-gain booster for simple screwdriver job-site matching of control system to speed, coil weight, etc.**

Write for NEW Bulletin EG84, which tells all about GPE Controls web guiding systems—and be sure that GPE Controls are specified and furnished on your next strip and tin mill installation.

GPE Controls Model 300 Edge Control, as furnished to Weirton Steel Company.

GPE Controls, Inc.
240 East Ontario Street
Chicago 11, Illinois

GPE Controls

A subsidiary of General Precision Equipment Corporation

How this simple heat transfer process can help you

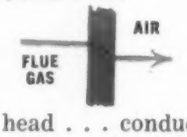
RECOVER AS MUCH AS 1,000°F FROM FLUE GAS

...and cut your fuel costs 1% for each 35°-40° F recovered

The advantages of preheating combustion air are many . . . more complete combustion . . . higher furnace temperatures . . . increased furnace capacity . . . improved product. On the basis of *fuel savings alone*, the Ljungstrom® Air Preheater should be carefully considered for many steelmaking applications since it can recover as much as 1000°F from flue gas, with savings in fuel costs of 1% for each 35°-40°F recovered. It is *the* most efficient metallic heat exchanger ever developed.

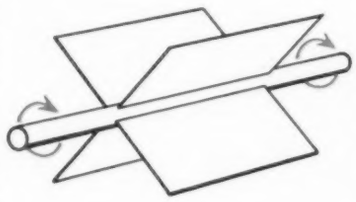
How the Ljungstrom works

Conventional recuperative preheaters are composed of tubes or plates with hot flue gas on one side and incoming air on the other, like this:

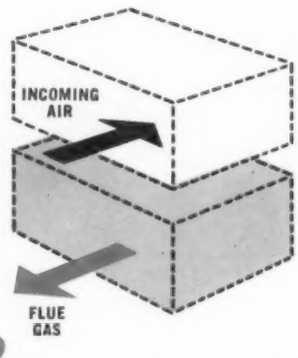


Heat must pass through the plate or tube wall. Its rate of flow depends on the heat head . . . conductivity of the metal . . . conductivity of the gas films on both sides of the metal . . . and upon the conductivity of any deposit adhering to the metal. The cumulative effect of these factors is so great that recuperative air heaters are generally quite large.

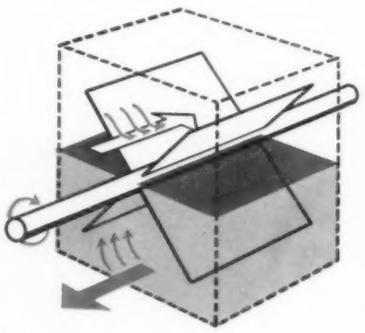
The Ljungstrom, on the other hand, is a *regenerative* air preheater. It keeps the incoming air separate from the flue gas, *but it exposes the same heating surface to both.* Heat need not pass through a film-deposit-metal-film barrier. It is simply absorbed by a heating surface, then released – from the *same* surface – to incoming air. Because of this operating principle, the Ljungstrom is remarkably compact as well as efficient. A unit measuring 5′ x 7′ x 8′, using 2000°F flue gas diluted to 1500°F, can handle a furnace exhausting 30,000,000 Btu/hr and raise incoming air from 70°F to 1400°F. The simplified sketches at the left illustrate the operating principle.



1 Basic heat transfer mechanism of the Ljungstrom is a rotor with thousands of square feet of metal heating surface. For simplicity, shown here as a paddle wheel.

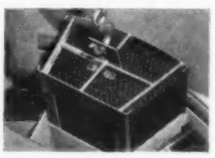


2 Housing of the Ljungstrom is arranged to permit counter flow of hot flue gas and cold incoming air. Gas tight seals separate flue gas from air.



3 As rotor revolves slowly through both flue gas and air streams, heating surfaces continuously absorb heat from flue gas and release it to incoming air.

In the Ljungstrom, the rotor heating surface consists of many formed metal sheets packed in baskets to give extremely large heat transfer surface. A height of *one inch* of Ljungstrom heating surface will recover as much as *one foot* length of conventional tubular heaters.



Applications in the steel industry

Ljungstrom's can perform efficiently in many steelmaking applications: reheat furnaces, soaking pits, slab, billet and skelp furnaces. Used in series with checkers they can provide far higher and more uniform preheating than any other heat exchangers now in use.

Tested and proved under all conditions

Ljungstrom's continuous rotary regenerative principle has been performance-proved for more than 35 years in over 3500 units. The electric utility industry (highly conscious of fuel costs) has virtually standardized on Ljungstroms. *Every* major U.S. utility is Ljungstrom equipped, with some units in continuous service since 1923. Refineries, chemical process plants – even ocean liners and cargo vessels – save fuel with Ljungstroms. For more information write

THE AIR PREHEATER CORPORATION

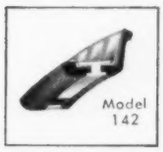
60 East 42nd Street, New York 17, N.Y.

ENGINEERED OIL SEALS
for Steel Mills

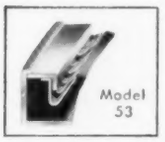
In severest atmospheres, Garlock KLOZURE* Oil Seals protect bearings from dirt, dust, lubrication leakage. Model 63 illustrated at right is a general purpose seal for shafts up to 3" diameter.

Where there is the slightest possibility of bearing damage due to oil leakage, apply Garlock KLOZURE Oil Seals.

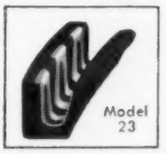
Everywhere in steel—on hot and cold strip mills, blooming and structural mills—Garlock KLOZURE Oil Seals prevent leakage of vital bearing lubrication. And they further prevent damage to the bearings by sealing out scale, spray, dirt, and other foreign matter.



For example, Model 142, a face-type oil seal, is designed to seal surfaces perpendicular to shaft . . . keeps water splash and scale out of bearings at the shoulder of mill rolls. Models 64 and 82 are applied to large shafts at normal or high speeds . . . ideal for protecting bearings on back-up and work rolls. Model 53 withstands temperatures up to 250°F at normal or high speeds . . . recommended for table rolls. Where equipment can't be dismantled easily, Model 23 Split-KLOZURES are the choice.



All KLOZURE Oil Seals are oil and grease resistant . . . impervious to water, mild acids, alkalies . . . non-abrasive . . . withstand temperatures from −40°F to +250°F. For extreme conditions, Garlock furnishes sealing elements resistant to practically any fluid, and serviceable as high as +500°F.



Enjoy prompt "off-the-shelf" delivery. A new, nationwide stocking program places over 1800 standard stock items of Garlock KLOZURE Oil Seals near you. All you need is a telephone for quick service on a badly-needed replacement oil seal, or to replenish your current stock of seals. For the name and address of the authorized Garlock KLOZURE Oil Seal distributor in your area, call the closest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, for further oil seal data, write for Catalog AD-181, Garlock Inc., Palmyra, N.Y.

GARLOCK

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

*Registered Trademark

Operation: Descaling

(Best in blast cleaning)

Rotoblast descaling saves $76,000 in first year!

New Pangborn Rotoblast vertical plate descaling machine pays for itself in one year at The J. B. Beaird Company, Shreveport, La. In fact, predicated savings of $64,000 were exceeded by 20% according to this pressure vessel fabricator, a subsidiary of American Machine and Foundry Company.

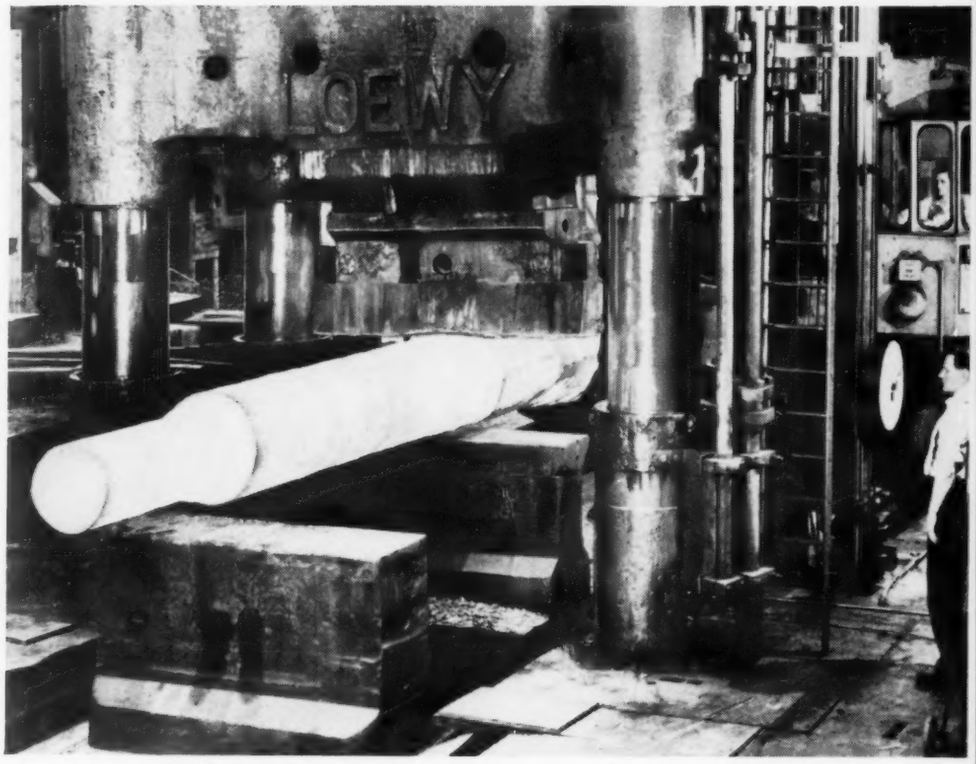
Vertical blasting cleans plate fast for fabricating and welding economies and frequently adapts well to plant handling facilities. Scale-free plate provides for trouble-free welds, cleaner fabrication—and holds paint longer.

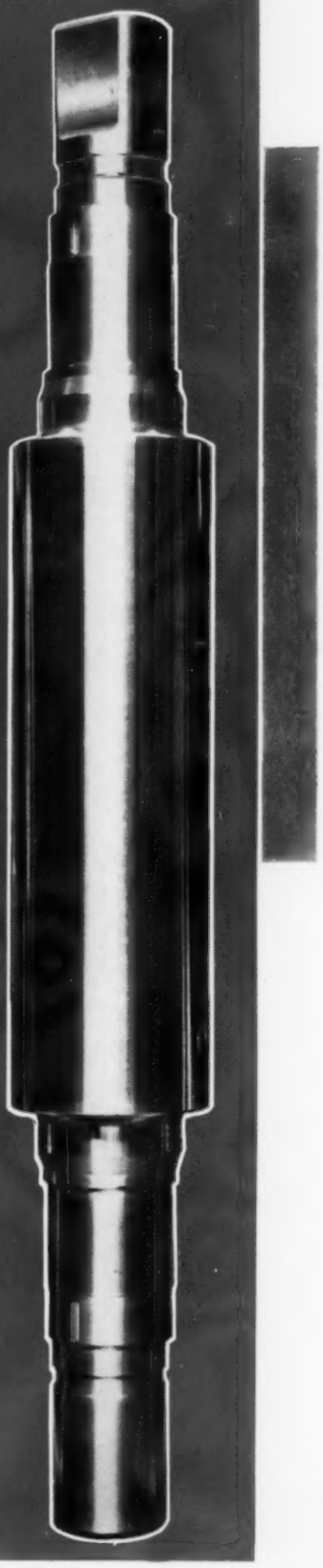
If your shop does descaling or blast cleaning, Pangborn will work with you to install cost-cutting Rotoblast equipment fitted to your specific need. (And whatever your cleaning job, extra-tough Rotoblast Steel Shot and Grit will last longer and clean faster.) To find out more, write to PANGBORN CORPORATION, 4400 Pangborn Blvd., Hagerstown, Md., Pangborn Canada, Ltd., 47 Shaft Road, Toronto (Rexdale), Canada or phone district office in Yellow Pages, "Sand Blast Equipment." *Manufacturers of Blast Cleaning, Dust and Fume Control Equipment, Vibratory Finishing; Rotoblast® Steel Shot and Grit®.*

Pangborn

OF HAGERSTOWN

Firth Brown
Forged Steel Rolls

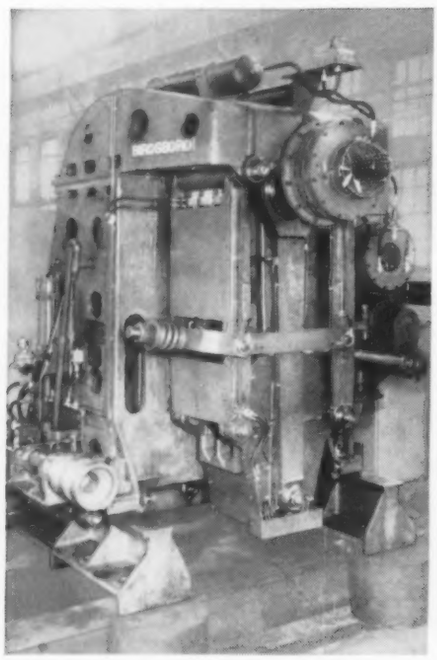


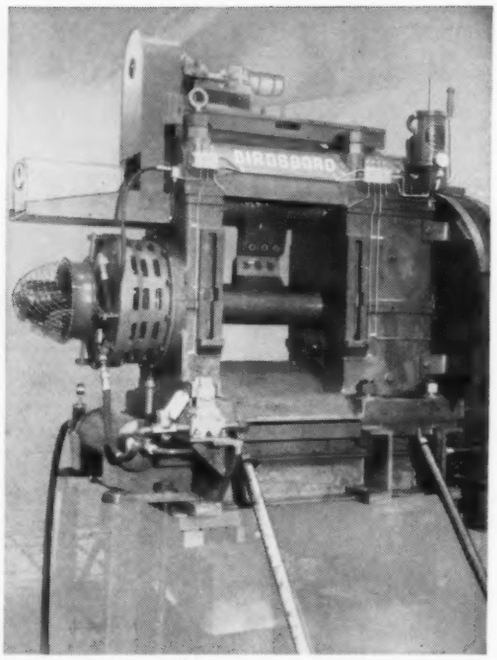


Hardened steel work rolls
by Firth Brown manipulate a very high proportion of all the metals rolled in Britain. Only greatly advanced metallurgical experience and superb technical skills in their making, could achieve their preferment and "choice by the experts".

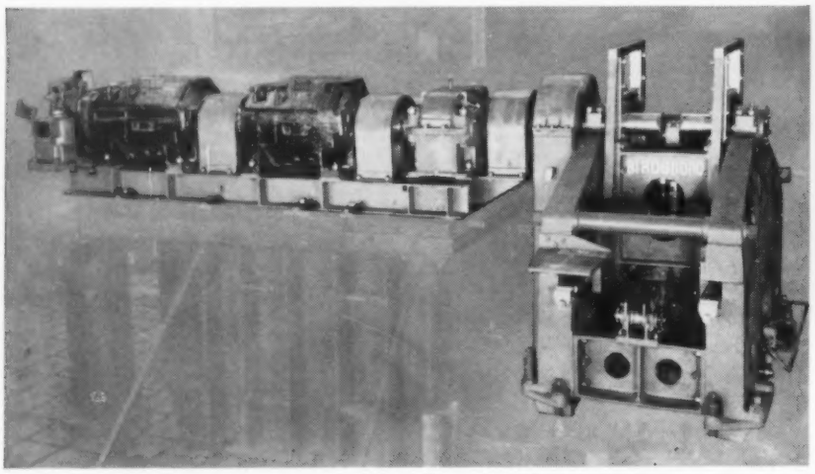
ALLOY STEELMAKERS
FORGEMASTERS
STEEL FOUNDERS
HEAVY ENGINEERS

Firth Brown
ATLAS WORKS · SHEFFIELD · ENGLAND

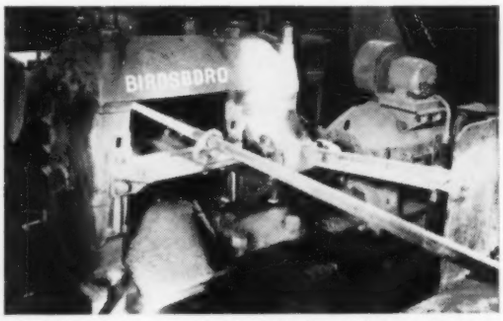




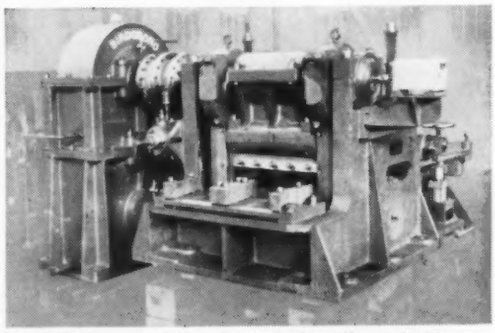
(Left) Pendulum type Flying Shear has an air clutch and brake on both swing and cutting drives, cuts 2¼" square billets at 600 FPM. The Shear is mounted on ways and is aligned with the pass by a motor drive, and clamped in place hydraulically. (Center) Overhung Flying Crop Shear has an air operated clutch and brake type flywheel drive with motor mounted on top of shear, reducing floor space to a minimum. Shear crops front and back end of ovals with areas up to .292 sq. in. at 800 FPM. The Shear is mounted on ways and is aligned with the pass hydraulically. (Right) Enclosed knife, air operated clutch and brake type flywheel drive, Cooling Bed Flying Shear divides 1 3/16" rounds at 2000 FPM at 10 cuts per minute.



Direct drive Flying Shear has a sliding knife frame assembly; cutting action is up and down, with clamping gag, giving square and distortion free cut at speeds of 100/400 FPM; bar is cut into twenty foot lengths.



Enclosed knife, single strand, direct drive, 25 H.P. variable voltage motor operated Flying Crop Shear; crops front and back end of 27/32" square bars at 415 FPM.



Pendulum type, direct drive Swing Shear divides up to 18 sq. in. billets emerging from furnace.

FLYING CROP AND DIVIDING SHEARS

designed and built by

MM 7-61

BIRDSBORO CORPORATION

BIRDSBORO, PENNSYLVANIA

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • ROLLS • ELECTRIC STEEL CASTINGS: Carbon, Low Alloy and STAINLESS STEEL

DIVISIONS: **MIRAWAL DIVISION • CHEMICAL MACHINERY DIVISION**

These P-G Steel Grid Resistors provide the resistance values needed to accurately control this 300 ton Alliance Stripper Crane.

P-G Resistors constantly prove their value on this 300 ton stripper crane . . .

P-G Resistors give trouble-free service on this stripper crane at Weirton Steel Company, division of National Steel Corporation at Weirton, West Virginia.

These rugged non-breakable resistor units built of steel and mica, plus P-G exclusive design have proved their worth in various types of service for more than 20 years.

For the maximum in resistor value try P-G the ORIGINAL Steel Grid Resistor for continuous service on stripper cranes and all other steel mill applications.

Write for Bulletin No. 500

Established 1892

P-G

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—**Kenton Lands Road, Erlanger, Kentucky**

MAILING ADDRESS—**Box 709, Covington, Kentucky**

Replace old-fashioned couplings with Rockwell-Standard's

BLOOD BROTHERS

HEAVY-DUTY INDUSTRIAL DRIVE LINES

ROCKWELL-STANDARD ENGINEERS specifically designed Blood Brothers Heavy-Duty Industrial Drive Lines to replace couplings in industrial applications. They improve machine performance and efficiency...last longer... give better service than any coupling. They often reduce costs by eliminating the need for bearings and supports required by conventional coupling installations. Wearing parts are quickly replaced and even drive lines can be replaced in 15 minutes!

Available in capacities up to 500,000 torque inch pounds, they are adaptable to a variety of applications—rolling mills, oil field equipment, irrigation pumps, cargo carriers, marine drives, logging winches, mining machinery and many others.

Blood Brothers Industrial Drive Lines offer these special features:

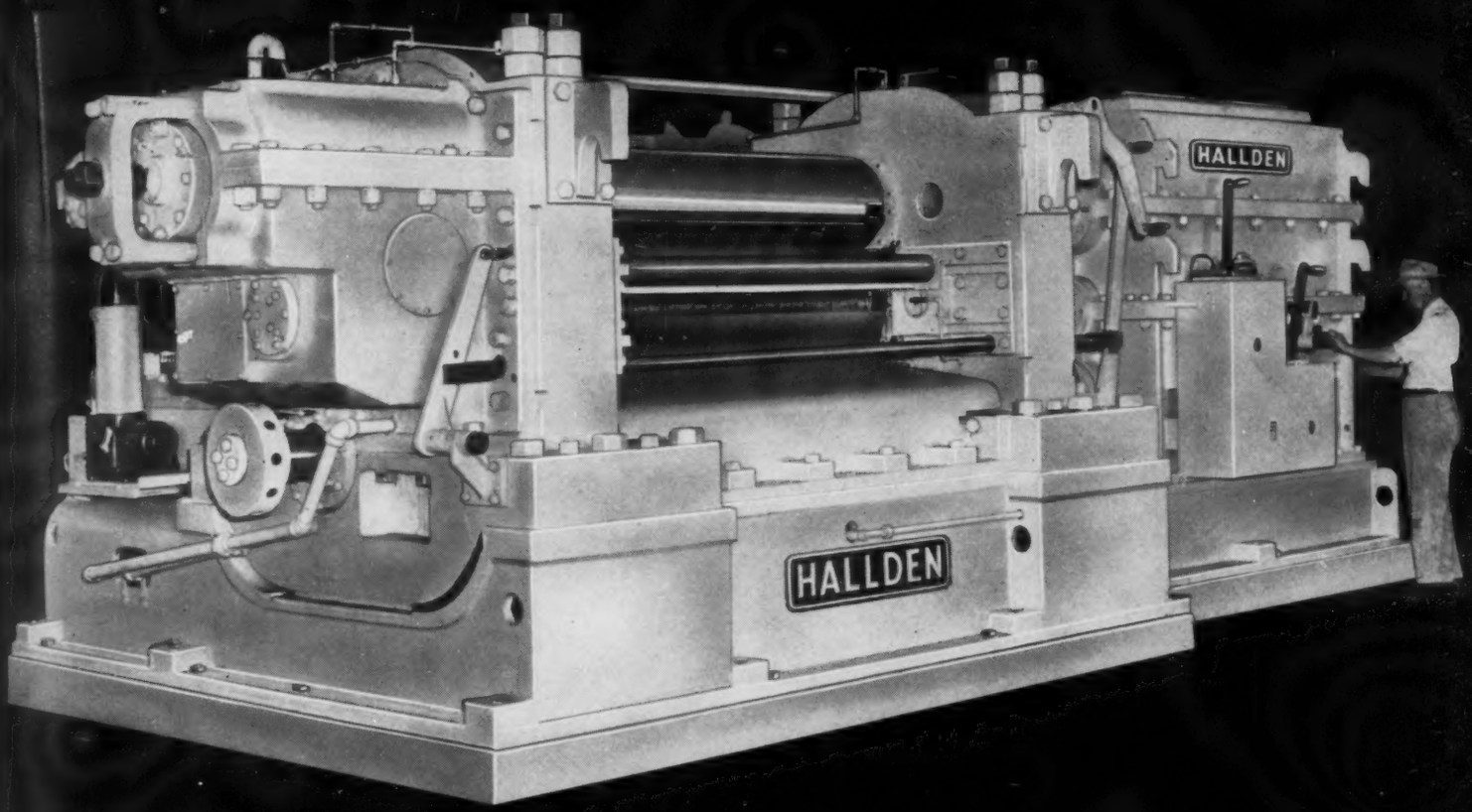
• Wing bushings that eliminate costly flange yokes and reduce down time during servicing. Simply remove 8 bolts for complete disassembly • Sliding spline provides for quick, easy assembly—variations in mounting locations—longitudinal shaft movements during operation—deflections and temperature changes • Easy access to lubrication fittings.

Another Product of...

ROCKWELL-STANDARD CORPORATION

ROCKWELL R STANDARD

Universal Joint Division, Allegan, Michigan



SYNCHRONIZED ROTARY SHEET SHEARS

Combine Accuracy, Speed, Durability

- **Infinite length-of-cut control**
- **Full synchronization**
- **Minimum adjustment**
- **Reliable performance**

All these features are assured by such Hallden design extras as hardened torque correcting surge gears, dynamically balanced components, precision fitted parts.

Hallden shears are engineered and built to meet the requirements for the most modern high speed strip processing lines.

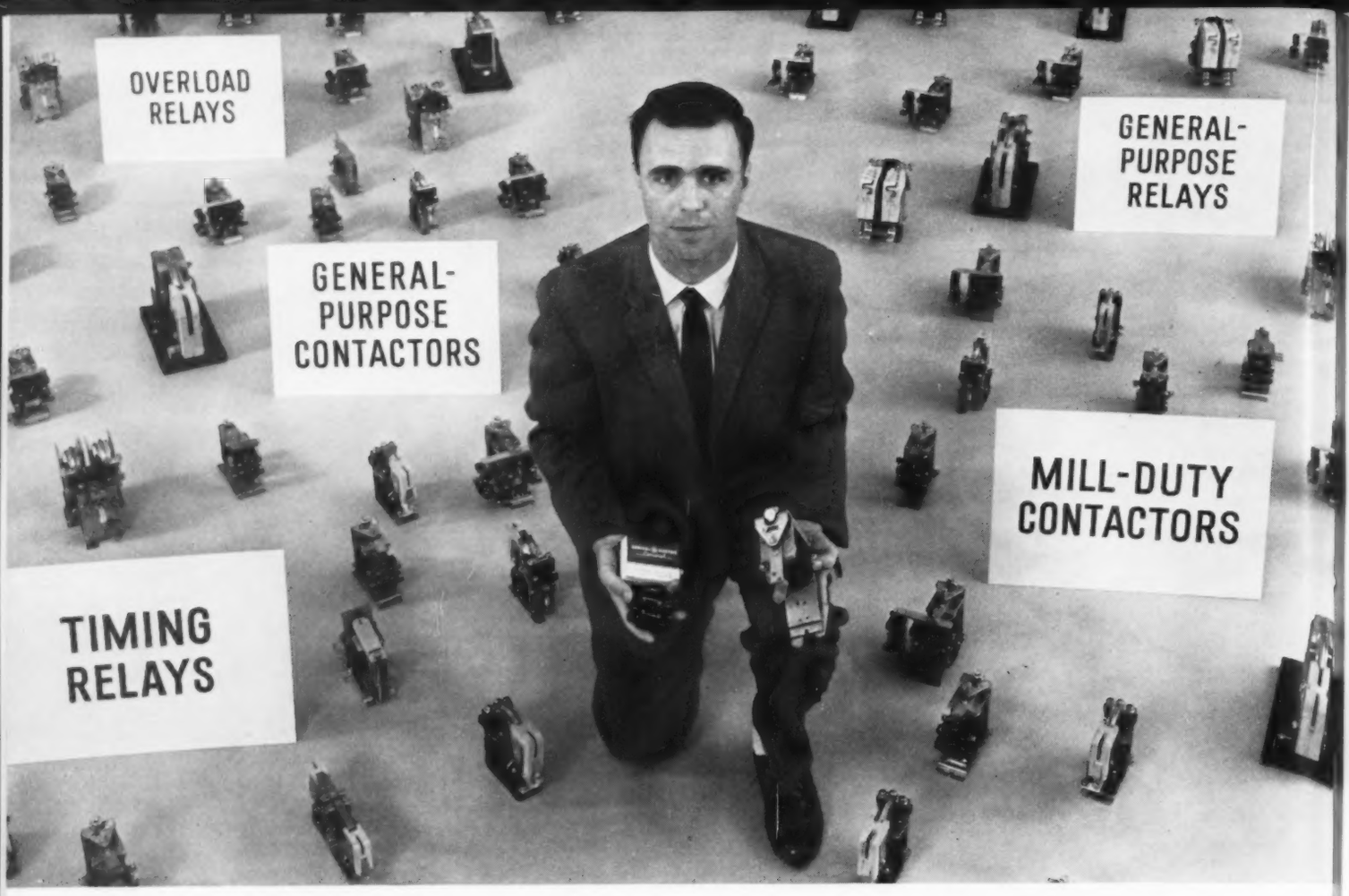
For custom designed synchronized flying shears for all high production strip shearing, consult Hallden, the worlds foremost designers of flying shears.

HALLDEN

The world's leading machinery manufacturers rely on Hallden shears in their process lines

THE HALLDEN MACHINE COMPANY • THOMASTON, CONNECTICUT

Associates: The W. H. A. Robertson & Co., Ltd., Bedford, England



WHY STOCK DC CONTACTORS AND RELAYS?

. . . when you can assemble more than 100 devices from General Electric "building-block" components

There's no need to carry a large inventory of d-c contactors and relays . . . just to be sure you have the correct device when you want it!

"Building-block" design of General Electric contactors and relays permits you to assemble more than 100 different devices—right in your own plant—from a stock of as few as a dozen standard components.

G.E.'s "universal" contact block is the building unit for all types of contactors and relays. Choice of standard frame-and-coil assembly with proper combination of contact blocks and standard assembly kit permits the variation in devices to meet your specific application requirements.

Three complete contactor lines and six relay lines—for general-purpose, mill-duty, overload, and timing functions—can be assembled using this unique approach.

Rely on General Electric for all components—General Electric also has complete lines of plate rheostats and resistors. For additional information, contact your General Electric Sales Representative, or mail the coupon below. *Industry Control Department, Salem, Va.*

GENERAL ELECTRIC

Resistors—vitreous-enameled and wire- and ribbon-wound types from 5 to 1210 watts. Fixed, slide-wire, or tapped types available.

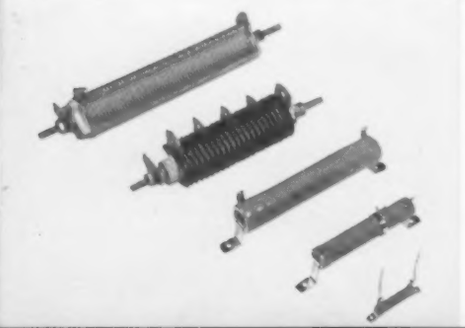


Plate-type rheostats—windings are completely encased in metal to give longer and more reliable service for any application.

To: Section H784-31
General Electric Co.
Schenectady 5, N. Y.

Please send the following bulletins:

- ☐ GEA-6621—D-c contactors and relays
- ☐ GEA-6592—Resistors
- ☐ GEA-6474—Plate-type field rheostats

Name_____

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Equipment News...

REFRACTORY CASTABLE

Δ A new refractory castable developed for low-rebound gun placement by The Babcock & Wilcox Co. Refractories Division for blast furnace use has a high resistance to carbon monoxide disintegration.

Results of tests conducted by an independent testing laboratory to ASTM standards indicated an unusually high degree of CO resistance for B&W's new Kaogun-BF, as compared to conventional castables recommended for blast furnace use. It showed no significant change in structure or strength while conventional castables completely disintegrated or showed severe break-up in the CO atmosphere. Test samples were first preheated in normal atmospheres at 1750 F following the recommendations of blast furnace operators for maximum service conditions. The samples were then subjected to a carbon monoxide atmosphere at 900 F for 40 hr (ASTM C-288-56).

A new type of high alumina hydraulic cement binder, developed by the B&W Refractories Division, plus special CO-resistant aggregate are credited with yielding Kaogun-BF's exceptional properties. By reducing rebound loss for pneumatic gun placement of the new castable, B&W has also been able to assure uniformity of the as-gunned monolithic structure, and, in addition, to provide significant savings in application of the materials.

Although developed for blast furnace use, the castable also has applications in other metallurgical and chemical processes where CO atmospheres occur. With a use limit of 2800 F+, Kaogun-BF can be applied to bosh, inwall and topwall sections of blast furnace stacks in a matter of a few days as compared to the weeks required for rebricking. Gun application of the new castable for interim repairs permits lower lining costs per ton of steel, and can possibly yield complete monolithic linings in a fraction of the time required to brick up a furnace.

Greater control of the properties of the as-gunned material have been made possible by reducing rebound losses to about one third as compared to losses sustained with conventional castables. Exact methods of determining and measuring gunning rebound have been developed by B&W laboratories as the result of extensive research into the effects of particle size, plasticity and other factors on rebound.

Applied by wet or dry gun methods, Kaogun-BF also minimizes dusting with a dry gun and provides good workability for wet gun placement. The new castable has exceptionally high strength—a maximum of 6000-psi cold crushing strength after heating at 2800 F, and 4150 psi for the dried castable. It has a high density of 135 lb/cu ft dried and 128 lb/cu ft fired. The material has no drying shrinkage. Permanent linear change after heating at 2800 F is + 0.4 per cent.

TRANSFORMERS

Δ A new line of distribution transformers for operation at 65-C rise is being readied for production at Pennsylvania Transformer Division, McGraw-Edison Co. Lighter and smaller than the company's present line, the new "Pole Star 65" transformers will incorporate heat-stable "TherMEcel" insulation, a major development announced recently by the Thomas A. Edison Research Laboratory.

The new transformers—to be produced in standard kva ratings—will be available in introductory sizes by the end of the year. The company reports that extensive testing of prototype models has demonstrated low losses, low exciting current, low impedance, high overload capacity and high short-circuit strength. Accelerated life tests have proved that "TherMEcel" insulation—specially treated kraft paper with high mechanical and electrical strength—possesses exceptional retention ability of all necessary characteristics when subjected to high temperatures

for extended periods. Characteristics studied included toughness, fold endurance, burst and tensile strength, tear resistance and dielectric strength.

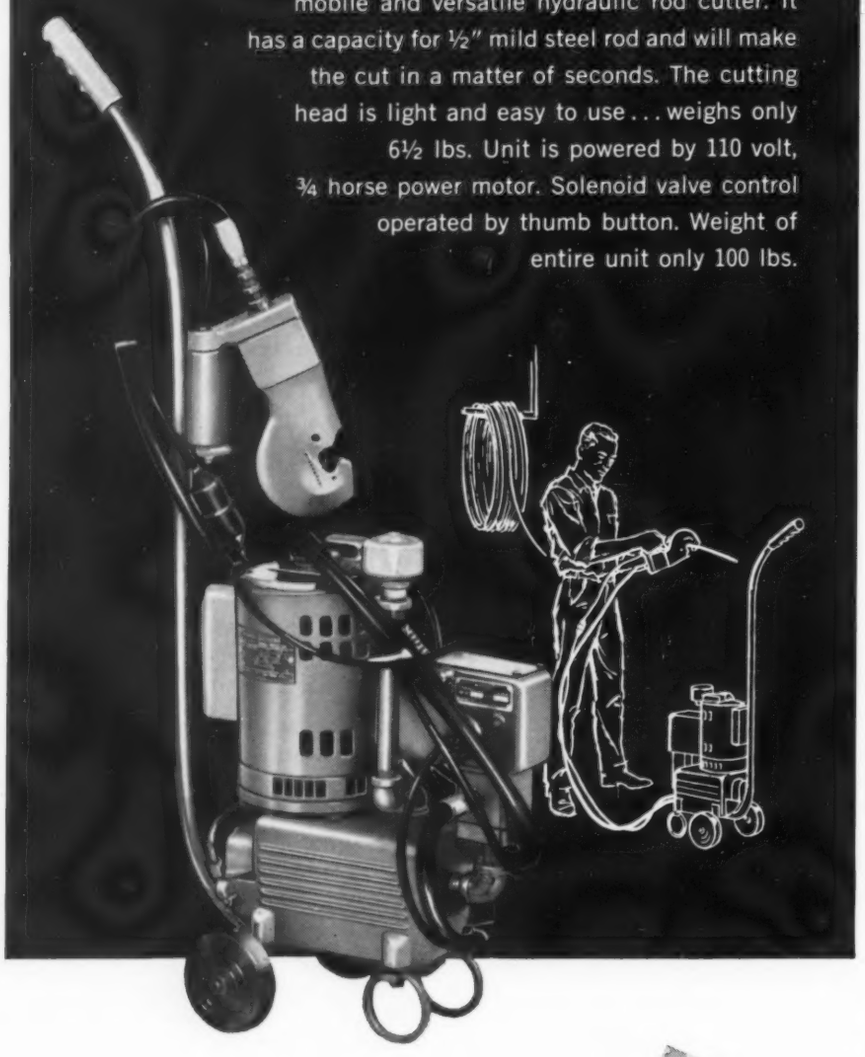
Pennsylvania Transformer several years ago initiated the request that led to the Edison Laboratory's heat-stable insulation project, which was sponsored by several McGraw-Edison divisions, because of the anticipated application of insulation with high thermal stability to power transformers, furnace transformers, network transformers and step voltage regulators as well as to distribution transformers.

ELECTRIC FEEDER

Δ The Cleveland Vibrator Co. announces a new electric feeder that screens dust from chunky materials and deposits both in separate containers. Originally designed for sifting dust from coke, the all-metal

NEW FAST PORTABLE HYDRAULIC ROD CUTTER

IDEAL FOR TAKING ROD SAMPLES AND OTHER CUTTING JOBS. Here is an exceptionally mobile and versatile hydraulic rod cutter. It has a capacity for ½" mild steel rod and will make the cut in a matter of seconds. The cutting head is light and easy to use . . . weighs only 6½ lbs. Unit is powered by 110 volt, ¾ horse power motor. Solenoid valve control operated by thumb button. Weight of entire unit only 100 lbs.



MANCO offers a complete line of hydraulic cutting tools, punches, rod straighteners. Write for Catalog.

DEPT. IS-11

MANCO MFG. CO.

BRADLEY, ILLINOIS

feeder can also be used for any process that requires separation of different sized particles or dust removal for sanitary or recovery reasons.

Called the Model 50SC, the feeder consists of two flat chambers divided by a screen or grid that sifts dust or small particles into the lower chamber. Discharge openings at the end of each chamber feed the separated materials into drums, bags, tote bins or back into the materials handling system.

An electric rotary vibrator mounted under the feeder moves the materials along the length of the feeder and provides a rapid sifting motion. This movement deposits dust into the lower chamber without throwing it into the surrounding area, according to the manufacturer.

The entire feeder is suspended from existing structures on springs that require no tuning or adjustment. Rate of separation varies depending on the type of material being handled and the slope of the feeder. Coke and dust deposited in surges is screened at a rate of approximately 4 cu ft per min.

This type of feeder is available in lengths from two ft to six ft and in widths from 12 in. to 24 in. Steel, aluminum or stainless steel models can all be cleaned with common cleaning materials.

PROTECTIVE RELAY

Δ A new hoist limit switch protective relay is announced by The Clark Controller Co. Designed to increase hoist safety and satisfy rugged hoist requirements, the new Bulletin 7328 Type XVR relay can be used with either new or existing d-c dynamic lowering hoist controllers.

The hoist limit switch protective relay opens the control circuit of a dynamic lowering hoist controller in the event of certain unsafe conditions in the power-type (Youngstown-type) hoist limit switch.

The Type XVR relay is recommended for use on hot metal cranes, heavy cranes, duplex cranes and any application where maximum safety is desired.

This relay minimizes damage to crane and personnel by preventing cycling in the limit switch zone, and assuring the magnetic brake will set when the crane reaches the extreme upper travel. Slow speed "back-out" in lowering direction is also assured.

"MIDVAC ROLLS are No. 1 on our list of roll quality and outstanding performance."
Ohio Steel Mill

"Better reduction than with any other set of rolls we have used."
Midwest Metal Mill

"The best rolls we have ever had for blast characteristics."
Midwest Steel Mill

PERFORMANCE-PROVED

UNSURPASSED FOR SERVICE BY NATION'S MILLS

From coast to coast . . . from all types of mills—steel, paper, foil—reports are coming in on the superior performance of Midvac Rolls. Their outstanding performance has proved their value in longer service, finer finishes and lower operating costs.

Midvac Rolls are made from consumable electrode vacuum arc melted Midvac Steels with super uniformity of fine grain structure . . . maximum freedom from defects and non-metallic inclusions. Machined and ground to a black, Micro-Lustre finish that assures rolling free of surface imperfections . . . quicker repolishing . . . longer trouble-free service between grinds. These rolls have cut repolishing time in half . . . lasted 33% to 50% longer on mill between grinds.

For a higher standard of quality and lower maintenance costs specify Midvac Rolls for your mill. Midvale-Heppenstall also makes forged steel rolls of any size, for any purpose required for rolling of steel, aluminum, copper, bronze and other metals . . . as well as paper, plastics and rubber. Write for complete details to . . .

MIDVALE-HEPPENSTALL COMPANY, Nicetown, Philadelphia, Pa.
Subsidiary of Heppenstall Company, Pittsburgh, Pa.
Plants: Pittsburgh, Pa.—Bridgeport, Conn.—New Brighton, Pa.

H MH *Midvac Rolls*

VACUUM AND CONSUMABLE ELECTRODE STEELS • BACK-UP ROLL SLEEVES • FORGED STEEL ROLLS • FORGINGS
RINGS • PRESSURE VESSELS • INDUSTRIAL KNIVES • DIE BLOCKS • MATERIALS HANDLING EQUIPMENT

A "peak chopper" is employed in the relay design to prevent nuisance crane stoppages, and give accurate protection even at slow crane speeds. The relay trip point can be set near the desired value because short current peaks will not cause the relay to give false operation.

An iron plunger with a small orifice rests on the bottom of a hermetically sealed brass core which contains a temperature stable fluid and is in the center of the relay coil. The orifice retards the movement of the plunger which is pulled up by an increase in the coil current. If the motor current increases to the preset value, the plunger rises, the magnetic lines of flux increase because of the shorter air gap, and the magnetic force pulls the armature down opening the relay contacts. Upon reset, the plunger drops to the bottom of the brass core and the contacts close.

Tripping value of the relay depends on the position of the brass core which can be screwed upward or downward in a threaded hole in the coil mounting bracket. Position can be accurately set by sighting across the bottom of the brass core toward marks on a calibration plate.

The contacts are carbon, nonwelding with vibration snubbers to prevent contact bounce. The simple construction, which has a proved history on crane service, employs only one contact and is available for either front or back connection.

CONTROL COMPUTER

△ The first industrial control computer employing Stored Logic has been announced by TRW Computers Co., a division of Thompson Ramo Wooldridge Inc. The new computer, called the TRW-530, is the third in TRW's line of control computers.

Stored Logic, an advanced concept in computer organization, tailors the TRW-530 to the needs of each user and gives the TRW-530 capabilities equal to the most complex control job. For example, in the process industries a TRW-530 can control several units within a plant complex. In the electric power industry, a TRW-530 can be applied to complete power station automation and to automatic power dispatch. In the primary metals industries, a TRW-530 can provide integrated control of several mills, shops and furnaces.

Features that contribute to the superior performance of the TRW-530 include—in addition to Stored Logic—parallel operation, large core memory and microsec operating speeds. These features make the

New Hawk 401 Utiliscope p

An Unprecedented P
Closed Circuit T

Impressed by the potential value of closed circuit television but *depressed* by reports of high initial cost, expensive maintenance, constant requirement for difficult adjustments, and general unreliability? Then listen . . . to an unprecedented proposition from the world's oldest manufacturer of industrial closed circuit television: Indoor or outdoors, in any kind of weather with practically any degree of illumination, Diamond Electronics' all new Hawk 401 Utiliscope is *guaranteed on a money-back basis* to provide a sharp, clear picture of just about anything . . . perimeter barriers, gates, transfer points, loading docks, construction areas, vehicular movement, rooftops, hazardous areas . . . all from one safe, comfortable and convenient location. The Hawk requires no special housing, no special power supply, no special adjustments for changing light and weather conditions. Just plug it into an ordinary 110 V outlet and forget about it.

See for yourself. Call, write or wire and we'll arrange a demonstration within the week.

Diamond Electronics
Diamond Power Specialty Corporation • Lancaster, Ohio

TRW-530 economical in programming, in operating time and in memory requirements.

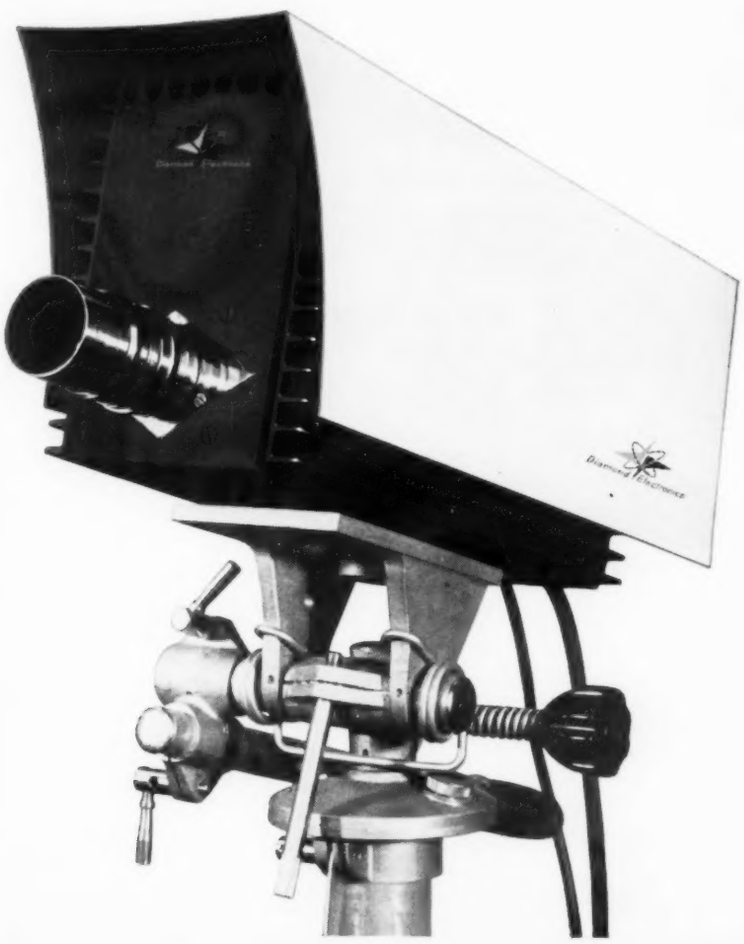
The TRW-530 communicates directly with process instruments and controls through analog and digital input-output equipment. For computer-operator communication, the following is available: an operator's communication console, electric typewriter with paper tape reader and punch, high-speed tape reader and punch, alarm printers and digital time-of-day clock.

Word length of the new machine is 18 bits. Up to 32,000 words are available in core memory; memory cycle is six microsec per word. Over 190,000 words are available in supplementary drum memory.

Because the TRW-530 employs the Stored Logic concept, sequences of logic operations are controlled by bit patterns stored in memory rather than being wired into the machine when it is built. The number and structure of commands available, therefore, is virtually unlimited. This makes the TRW-530 useful not only as a control computer, but also as a scientific machine or as a data processor.

permits...

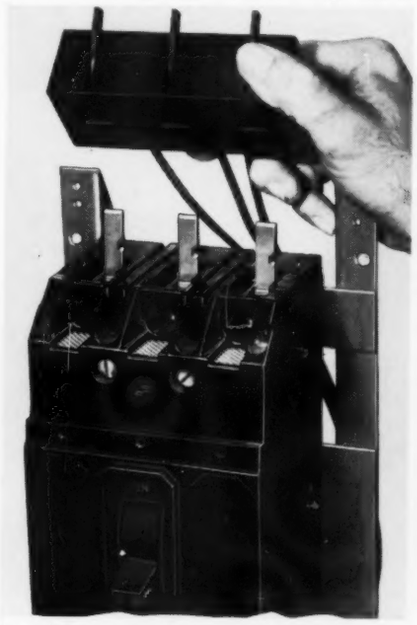
Proposition In Television...



LINE COUPLER

Δ A new line coupler which permits safe and easy removal of circuit breaker and starter equipment has been added to Square D Co.'s spin top enclosure for hazardous locations.

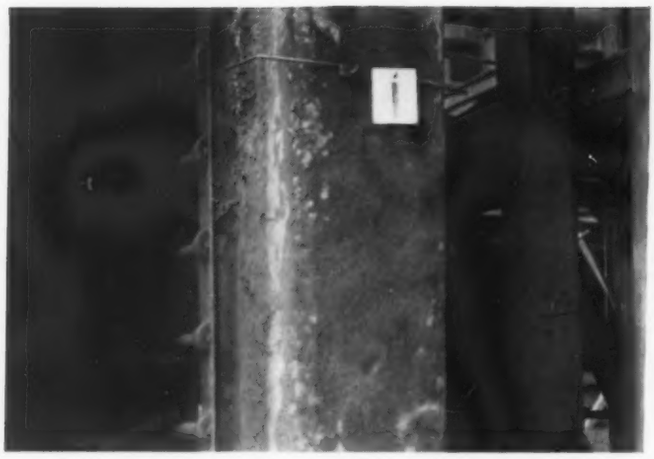
The new line coupler makes it unnecessary to disconnect the main power feeder to remove a unit. The branch connectors are fully insulated for complete safety to personnel. Hot lines cannot come into contact with any part of the enclosure.



The line coupler mounts on a standard circuit breaker using stabs which are installed in the line terminals. The unit is in production with a 50-amp rating, and is designed to withstand the same fault currents as the F frame circuit breaker.

UNIVERSAL JOINTS

Δ A new line of heavy-duty industrial universal joints designed to provide high horsepower capacity and (depending on the angle of operation) at speeds up to 1750 rpm is now available from Lovejoy Flexible Coupling Co. Single joints provide smooth, sensitive operation through a full working angle of 40 deg, double joints through 80 deg. Rated at 0.41 to 150 hp at 100 rpm, in a size range from $\frac{3}{8}$ in. to 3 in., they are available either solid or



B&W Kaocrete-D, vibrated in place, provides high resistance to the atmospheres encountered in this coke oven door installation. Furthermore, the high erosion resistance and long service life without loss of strength of B&W Kaocrete-D add to its suitability in this application.

A typical monolithic curb wall construction in an annealing furnace using a carbon monoxide atmosphere. The greatly reduced number of joints in which sealing sand can penetrate prevents structural spalling of B&W Kaocrete-A upon heating and cooling. Being monolithic, gas leaks are practically eliminated.

A radiant tube annealing furnace with a base of Kaocrete-A, backed up with Kaolite-20, one of B&W's insulating refractory castables. This furnace operates at approximately 1700 F in a 65% CO atmosphere.

A stack annealing furnace with pedestals cast of B&W Kaocrete-A. The atmosphere is slightly above 8% CO. B&W Kaocrete-A offers strength, volume stability and resistance to carbon monoxide disintegration.

How B&W refractory castables perform in atmosphere applications

One of the difficult problems facing furnace builders and operators in the metals industries is the effect of atmospheres on refractory linings. That's why B&W offers several *specialized* refractory castables for this service, each possessing strength, volume stability and the refractoriness necessary to assure long, trouble-free service.

Take B&W Kaocrete-A, for example. Because of the careful selection and processing of special aggregates and other ingredients with low iron content, this material resists disintegration or other effects produced by high concentrations of CO or H_2 atmospheres. B&W Kaocast and Kaocrete-32 provide the same excellent service at higher temperatures while lightweight Kaolite-20 is outstanding as an insulating castable in atmosphere applications.

B&W Bulletin R-35A gives additional information on versatile B&W refractory castables. Write for your copy of this bulletin to The Babcock & Wilcox Company, 161 East 42nd Street, New York 17, N. Y.

R832

B&W THE BABCOCK & WILCOX COMPANY

REFRACTORIES DIVISION

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.

bored. Bores other than standard are available, including square holes.

The high horsepower capacity at high speeds is accomplished by a specially-designed yoke which features ears of exceedingly high strength and permits full freedom of movement of the joint. Case hardened and fine alloy steels are used to achieve light weight and exceptional durability. Stainless steel in various grades is also available for some sizes, as well as bronze bushings surrounding the pin.

LIFTING MAGNETS

△ Ohio Magnetics, division of The Ohio Electric Mfg. Co., announces a new line of light weight, aluminum-wound magnets that are claimed to outperform any lifting magnets known to the industry.

Ohio DM magnets provide all the advantages of the well-known bolted-type construction along with the longer life of the welded style that cuts maintenance costs. Sizes available now from stock are 39, 46, 56, 61 and 71 in. diameters. Other sizes are available on special order.

Because of their greater lifting capacity and lighter weight, Ohio DM magnets cost substantially less than other magnets of equivalent lifting capacity.

The series magnets are highly adaptable and feature an extra deep field for penetrating into light gage scrap and turnings, for use with heavy castings, forgings, pigs or other ferrous metal shapes. Shipboard, dockside or yard service uses are suggested as are general mill applications since the unusually robust construction of Ohio DM magnets shrugs off the most rugged type of service.

From a technical point of view, superiority of design and construction is claimed in several important areas: lifting coil, magnet body castings, terminals and terminal housings.

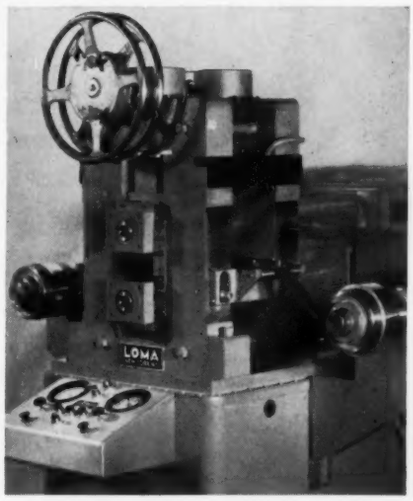
The coil is wound with anodized aluminum for 75 per cent duty cycle; has lower temperature rise and increased field strength for longer life; high-temperature mica disks bonded with the best resins available are used for coil insulation. Magnet bottom plate is cast of ribbed man-

UP-DATE YOUR HOISTING EFFICIENCY

Cranes, cabs, trolleys, bridge systems are custom rebuilt by POLLOCK. Redesigned and re-engineered to meet the optimum operating requirements of your plant. POLLOCK will step-up your hoisting speeds by installing larger motors and heavier-duty gear mechanisms. Increase service rating, reduce maintenance, with renewed motors, shafting, bearings and gearing. Recondition and up-date your electrical controls. For experienced custom rebuilding, contact:

POLLOCK
ENGINEERING CO., INC.
POTTSTOWN, PENNSYLVANIA

NEWS FROM LOMA



This rugged and versatile reversing 2-high / 4-high combination mill brings high-precision rolling of thin-gauge ferrous and non-ferrous strip within reach of the smaller re-rolling mill, metals pilot plant and research laboratory. Occupying only 35 sq. ft. of floor space and involving a cost of less than $20,000, the machine handles up to 6 in. wide strip at rolling speeds up to 250 ft. per min. with accurate front and back tension control.

The new 8 in. mill is furnished with two sizes of 4-high work rolls, made of either alloy tool steel or solid tungsten carbide: the 1½ in. size is used for normal cold reduction down to 0.002 in. thickness, and the ¾ in. size allows special ultra-thin finishing to gauges of less than 0.001 in. In the 4-high setup, the machine handles up to ⅛ in. gauge; the 2-high arrangement is used for the hot or cold breakdown of heavier materials up to 1 in. thick, but is also available for skin pass rolling of thin strip.

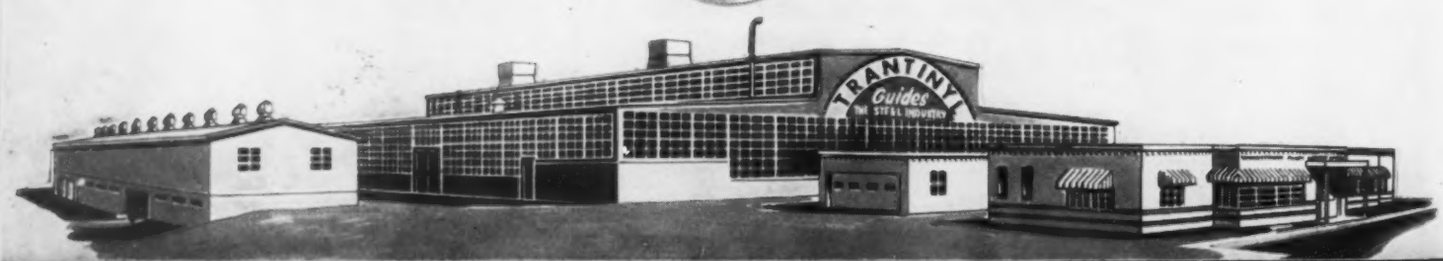
The production of close-tolerance stock is assured by an exceptionally rugged mill design, employing steel housings of 160 sq. in. post area, super-precision needle roller journal bearings of 175,000 lb. separating force capacity, a heavy-duty mill drive with herringbone gearing and universal joint spindles, and twin-handwheel worm drive screwdowns. The machine is powered by a four-speed reversing drive offering constant horsepower from 40 to 250 ft. per min. rolling speed.

The outstanding feature of the new machine is its reversing strip coiling attachment allowing the two-way rolling of strip under tension control with no more effort than a mere flick of a selector switch. Mounted on brackets at either side of the mill, the two coiling shafts carry 8 in. diameter reels designed for a coil buildup of 6 in. Both shafts are driven from the pinion stand and are provided with dual air-operated slip clutches and brakes of ultra-sensitive, low-inertia design. Selective operation through solenoid valves and pressure regulators precisely controls the front and back tensions desired for any given mill pass.

LOMA
MACHINE MFG. CO., INC.
114 East 32nd Street
New York 16, N. Y.

TRANTINYL

guides the steel industry



YOUNGSTOWN ALLOY CASTING CORP., • YOUNGSTOWN, O.

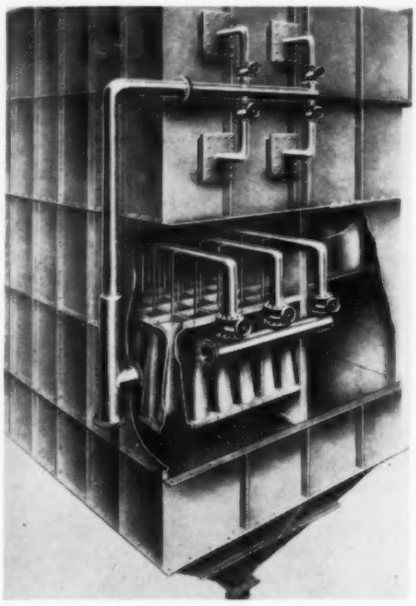
ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc.
ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

ganese steel for greater strength and minimum weight. The integral cast case gives greater strength and eliminates seams and seals. A stainless steel plate, welded between outer ring and center of magnet, provides a permanent watertight joint to seal the coil from the atmosphere. The external terminal box design is gasketed and sealed with rubber bushings for strain relief on electric leads. Insulated terminals are assembled within the terminal box and last the life of the magnet. The magnet is supplied with a cast manganese steel suspension chain.

VENTURI SCRUBBER

Δ Buell Engineering Co., Inc., announces a new venturi scrubber for separating entrained solids from high-temperature gases.

The scrubber is manufactured under an exclusive U. S. license from Waagner-Biro, Austria, and offers



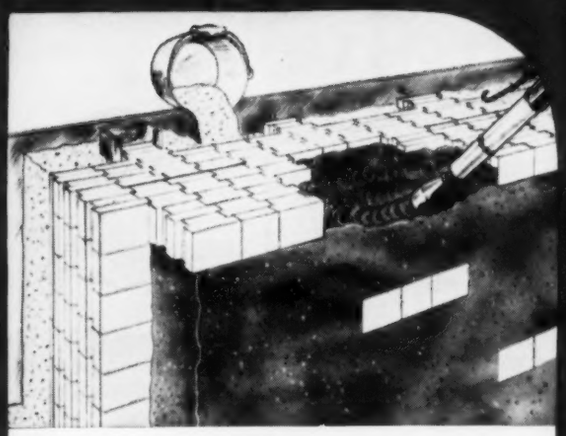
advantages of low pressure drop and low water requirements. These in turn result in lower power requirements and lower operating costs. Although the scrubber is new in this country, it is in use in continental Europe, Great Britain and Japan. The first U. S. application will be in removing entrained solids from steel mill exhaust gases.

The scrubber is unique in that it subjects the exhaust gases to a double scrubbing action as they pass through a bank of venturis. At each venturi, a nozzle sprays a cone of water into the belled venturi entry, and the gas receives its first scrubbing as it passes through this wall of spray.

It receives its second scrubbing within the venturi as it passes through a second inverted cone formed as the water rebounds from the belled mouth into the throat of the venturi. This deflection of the water decreases its velocity and breaks it into smaller droplets. While this takes place, the velocities of the gas and entrained solids are increased, due to the narrowing throat of the venturi. Thus, the faster moving gas stream passes through the slower moving water spray and is subjected to the second scrubbing action. The scrubber cleans gases of dust particles as small as 0.05 micron at efficiencies of 99 per cent plus.

ATMOSPHERE GENERATOR

Δ A vapor generator, designed to eliminate oxide scale formation during hot working of metals, has been developed by Lithium Corp. of America. Trade named the Lithium



Presenting the

DETRICK COMPOSITE WALL

A REALISTIC APPROACH TO REFRACTORY ENGINEERING

The central section or "core" of the wall—of preburned refractory tile—adds strength and permanence to the overall structure. The hot face—a layer of plastic firebrick—attains full-depth ceramic bond, is easier to patch and repair and dries out faster, thus reducing down time during rebuilds. The outer surface—of insulating castable—minimizes heat loss. All metal anchors are in cool zone—insurance against one of the most common causes of wall failure. A Detrick-engineered COMPOSITE of constructions, each contributing to the goal of longer life and lower maintenance.

Competitive in Cost. Write for Bulletin D-52.

DETRICK Heat ENCLOSURES ®

M. H. DETRICK CO.

111 W. Washington St., Chicago 2

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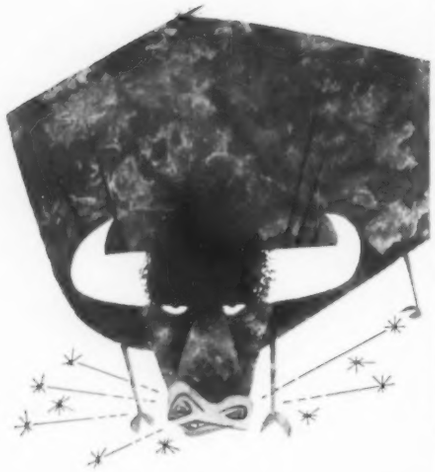


Flash Welded!

9/32" thru 2"

Taylor's Tougher

It's news! Taylor electrically flash welds ALL SIZES of TM Alloy Steel Chain! Every weld is positive, free of oxides and foreign materials. In addition, all TM Alloy Slings have patented Tayco Hooks—undergo rigid quality control, link-by-link inspection and scientific testing. These factors plus a signed Test Certificate assure maximum, trouble-free service and lower costs! Call your distributor or write direct for Bulletin 14-A today.

Chain is our specialty — not our sideline!

Taylor Made CHAIN SINCE 1873

S. G. TAYLOR CHAIN CO., Inc.
General Office: Hammond, Indiana
Plants: Hammond, Ind., and Pittsburgh, Pa.

Vapor Generator, it provides a simple and effective means of injecting vapors of lithium compounds into the working atmospheres of hot mills and furnaces to keep metals bright and clean without bulky equipment and complicated chemical control.

The vapor generator is a compact chamber that can be attached to the wall of the hot mill or furnace. It is fitted with a standard gas burner that utilizes plant fuel gas. Electrical controls are located in a separate panel box that can be mounted nearby or at a remote point.

The source of lithium vapors is a cylindrical cake consisting of a eutectic mixture of lithium chloride and lithium carbonate, each cake individually wrapped and sealed in polyethelene to prevent moisture absorption. Each unit charge contains 7⅛ oz of the mixture, an amount ordinarily sufficient for an eight-hr run. The lithium compounds used are nontoxic.

The generator is constructed of standard components and is easy to dismantle and inspect. It requires a minimum of operator attention and maintenance.

5 CONTACTORS—STARTERS

△ New NEMA Size 5 contactors and starters—up to 65 per cent smaller in open forms than previous designs—have been added to General Electric Co.'s family of 100-line motor controls.

In addition, the open forms are as much as 41 per cent smaller in the critical height dimension. Dimensions of the new open starter are 14¼ in. high, 11¾ in. wide and 9 in. deep. The enclosed forms, also smaller than previous designs, are 31⅛ in. high, 15¾ in. wide and 10½ in. deep.

Inspection and maintenance are easy on the new size 5. Only the screws on the coil retainer need be loosened and the one-piece moveable contact, coil and magnet assembly pulled out to allow visual inspection of the contacts. No wiring is disturbed during contact inspection or coil change.

The enclosed forms have a total of 10 combination knockouts—three at the top and bottom and two on each side. The enclosure also has keyhole slots for easier mounting.

Wiring is easy in the enclosed forms since there is plenty of space available—7¼ in. at the top and 7 in. at the bottom.

All connections on the size 5 are made from the front. Solderless pressure-type terminals speed hookup time. Terminals on the size 5 will take up to 500 mcm cable. Straight through wiring also makes the installation easier and helps to save wire, since the wiring does not have to be bent around the starter.

The new form utilizes a horizontal straight line magnet action. The contacts are slanted, preventing dust accumulation and contamination. The arc is contained and quenched in an arc chute design of metal grids and a special arc-extinguishing compound.

Overload relays on the starter are adjustable plus or minus 15 per cent of nominal heater rating by just turning a knob. This helps prevent nuisance tripping when various ambient temperatures are present. The bimetallic overload relays are trip free so that if an overload occurs, contacts cannot be held closed until the motor has cooled.

Knockouts are supplied in the enclosure covers for adding an indicating light, pushbutton or selector switch. Other available modifications include: auxiliary contact kits; third overload relay kits; fuse clip kits for combination forms; coil kits for changing voltage or frequency.

The size 5 is rated up to 200 hp, 600 volts.

SWITCHES

△ Cutler-Hammer has announced the availability of its newly-designed Type D, mushroom button foot and palm operated switch featuring a bright orange, 5-in. diameter operating button which is ideally suited for use as an emergency stop station or a multi-switch starting station.

The button provides the cover for the Type D switches and is secured to the enclosure by the nameplate screw located in the center of the button. Removal of the nameplate screw and operating button provides easy access to the precision unit switch terminals.

The precision unit switches, which are mounted with the terminals up for good terminal wiring accessi-

bility, are operated by depressing the operating button. This depression opens the normally closed contacts and closes the normally open contacts. The switches are available with one or two precision unit switches providing a 1NO-1NC or 2NO–2NC contact arrangement.

The NEMA 1 enclosure has a die cast case and button. A bellows-type seal around the button provides resistance to the entrance of foreign materials. These switches are provided with two ¾-in. pipe tapped conduit entrances for straight through wiring, one of which is supplied with a pipe plug.

The indicating plates describe the function of the Type D switch—stop (red); start (black) or blank plate for special legend markings.

SPEED CONTROL

△ A new, patented self-locking speed control is being offered as standard equipment on integral horsepower U. S. Varidrive motors, it has been announced by U. S. Electrical Motors Inc. The new control assures that any rpm setting will be maintained without "drifting" or "creeping," until the operator chooses to change speeds.

Cam and rollers are so arranged as to lock the speed-changing mechanism until force is applied to the handle. Even a slight force on the handle is sufficient to release the cam and rollers to permit speed adjustments, yet as soon as the force is removed, the mechanism immediately locks in place automatically without slippage.

Company engineers report that with the new device, the operator can literally "set it and forget it" as far as speeds are concerned. They state that the only supervision needed is for the driven machine or the material-in-process, rather than the drive.

FORMING SYSTEM

△ The first commercial packaged electrohydraulic forming system has been announced by the Westinghouse Electric Corp. The system can store up to 42,500 joules at 20,000 volts, can be charged to full voltage in about three minutes, and the rate of discharge is 33 microseconds per cycle.

Electrohydraulic forming is a system for performing, through controlled energy discharge, the same operations now done on heavy press machinery.

Some of the unique advantages of electrohydraulic forming:

1. Can form metals that are difficult to work by conventional means due to work hardening or other undesirable attributes.
2. Can make shapes that are difficult or impossible to achieve by conventional methods.
3. Low cost, because plastic or wooden dies can be used.
4. Permits speedy design changes as "trial and error" modifications of dies are easily made.

The system consists of a bank of low inductance energy-storage capacitors, special switches for discharging this bank into the load, interconnecting leads, a d-c power supply for charging the capacitors, and the required controls for operating the device. The system is packaged in two parts: a control console; and a separate modular power unit, consisting of d-c power supply, capacitor bank, and switches. Additional modular power units can be added to the single control system to increase system capacity, provide more reliability, or give longer life.

The power unit is 8 x 4½ ft and 4½ ft high; the control console 2 x 2 ft and 4½ ft high. Control and auxiliary equipment is guaranteed for one year and the capacitor units are guaranteed for one year or 1000 shots.

PROTECTIVE COATING

△ Industrial Metal Protectives, Inc., has announced its newest protective coating, Zincilate RCP—Rust Converting Primer. Applied by brush or spray to any rusted ferrous metal or galvanize, RCP penetrates to the base metal and lays down an iron phosphate coating that completely severs all contact between rust and metal.

Rust is actually converted into iron phosphate, then RCP creates a moisture-proof primer that effectively prevents future rusting. This triple action eliminates the need for a separate primer coat which is required when ordinary

(*Please turn to page 272*)

Taylor's Tougher end to end!

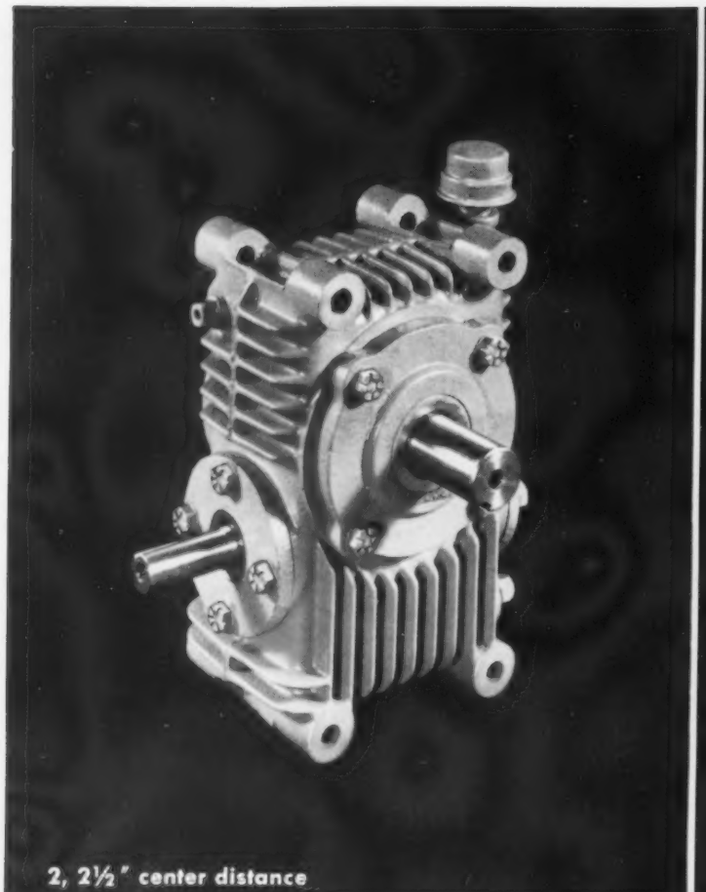
SIZES—9/32" thru 2"

Special analysis alloy steel . . . electric flash welding . . . controlled heat treating and patented Tayco Hooks make TM Alloy Sling Chains tougher! Link-by-link inspection, scientific testing and signed Test Certificate are additional reasons why TM Alloy Chain is preferred by safety engineers . . . material handling men . . . production superintendents! Call your distributor or write for Bulletin 14-A.

Chain is our specialty—not our sideline!

Taylor Made CHAIN SINCE 1873

S. G. TAYLOR CHAIN CO., Inc.
General Office: Hammond, Indiana
Plants: Hammond, Ind., and Pittsburgh, Pa.



2, 2½″ center distance

3, 3½″ center distance

Custom-build Your Worm Gear Drive from . . .

OVER 200,000 STOCK

The four "worm-under" speed reducers shown above represent only eleven sizes of standard, Cone-Drive units. Also standard are 15″, 18″, 22″, and 24″ center distance units. Cone-Drive worm gear reducers are available in ratios from 5:1 to 4900:1 and up to over 1200 HP capacity. All units feature the double-enveloping principle in which the worm and gear wrap around each other for greatest tooth contact, strength, smoothness, shock-resistance and quietness of operation.

All Cone-Drive worm-gear reducers feature heavy, ribbed, nickel-iron castings for maximum strength and heat dissipation. Heavy-duty taper roller bearings provide anti-friction support to both worm and gear shafts. Chrome-molybdenum-nickel steel worms and tin bronze gears provide long life and high strength. The Cone-Drive design also gives the exclusive benefit that, in service, both gear and worm tend to regenerate their true form . . . worm and gear wear "in" rather than "out."

Standard Options

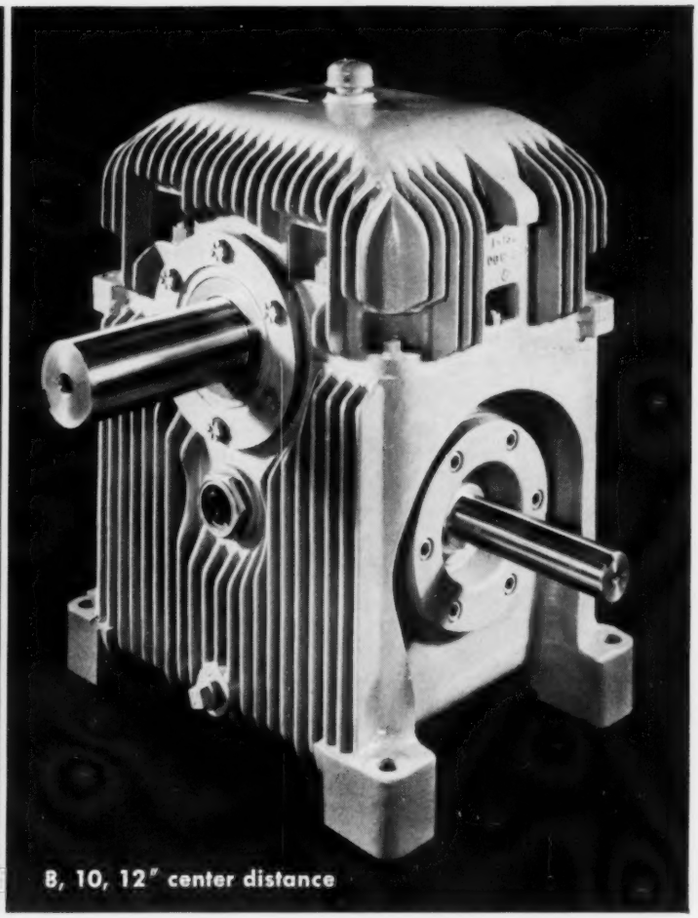
By selecting various options, standard units can be obtained to fit almost any drive requirements. By taking advantage of these options in the early design stages, you can often simplify design and improve performance, too. Including size and ratio ranges and options available, Cone-Drive Gears offers over 200,000 worm-gear speed reducer combinations that are standard, shelf-hardware items. Special sizes and ratios can be furnished on a quotation basis. Write for Bulletin CD-218 for complete details.

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

DOUBLE-ENVELOPING WORM GEARSETS | DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS | DOUBLE REDUCTION WORM GEAR SPEED REDUCERS | DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

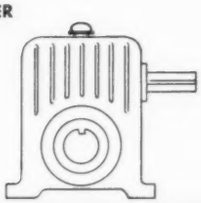
4, 5, 6, 7″ center distance



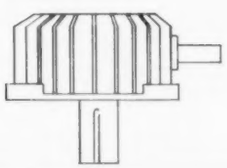
8, 10, 12″ center distance

CONE-DRIVE REDUCERS

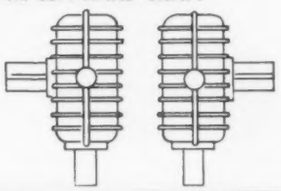
WORM-OVER



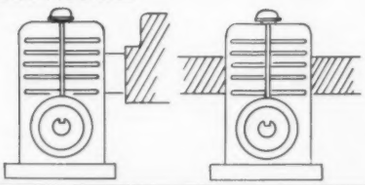
VERTICAL GEARSHAFT



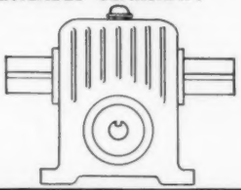
RIGHT- OR LEFT-HAND SHAFT



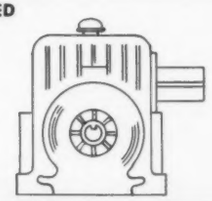
SHAFT MOUNTED



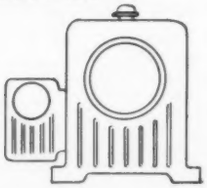
DOUBLE-EXTENDED GEARSHAFT



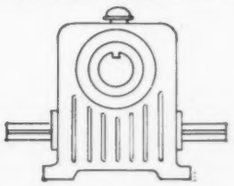
FAN-COOLED



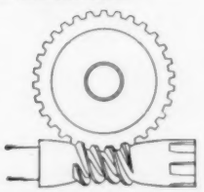
DOUBLE REDUCTION



DOUBLE-EXTENDED WORM SHAFT



GEARSETS & MOUNTINGS



(*Continued from page 269*)

wash-prime, phosphatizing or other similar trade-name processes are used.

Zincilate RCP is used to repair rusted galvanize and ferrous metals and to prevent rusting of new materials and products. Because RCP does not affect sound painted or galvanized surfaces, it is ideal for spot repair work. This clear coating is especially useful in protecting new materials as, on clean surfaces, it etches the metal to create a firm bond that insures complete protection even when coated materials and products are subject to outdoor storage for extended periods.

Surface preparation prior to the application of Zincilate RCP is limited to simple degreasing and even this is necessary only under extreme conditions. RCP can be successfully applied directly over any tightly adhering rust or scale. Sand blasting, or multi-stage cleaning, is not required.

The converting-priming action is unusually fast. Minutes after application even the heaviest rusted areas are converted, presenting a dark appearance entirely free of active rust. In more lightly rusted areas, the base metal is restored to its original appearance. The primer coat produced in the second phase will accept a decorative topcoat two hours after application, without any further preparation.

Zincilate RCP breaks all contact between rust and base metal. Because rusting is a constant chemical action, even the most minute contact between the rust and the base metal will allow rust to creep and grow.

WELD CONTROL RESISTOR

△ A simplified method for the accurate control of weld current in arc welding processes has become available in a new weld control resistor developed by Electric Arc, Inc.

Called the "Weld Grid" control resistor, it is currently available in three-man and six-man station models, as well as in a single station unit. Each station has three selective, dial-rotary switches for the incremental control of welding current in five amp steps to 300 amps, instead of a crowded panel of individual pull switches.

The resistor provides the precision needed in arc welding processes for easy operation and efficient work. Features include the use of high-temperature wire for long-lasting, breakdown-free service, waterproof input and output connectors, and construction to meet military specifications for salt spray, humidity and fungus resistance. An innovation is the use of wire-wound instead of ribbon-wound resistors for cool operation.

FLYING SHEAR

△ A self powered flying shear has been developed by G. M. K. Precision Machines, Inc., to provide a compact automatic cut-off unit for roll strip material.

"Size-O-Mat" occupies less than eight square feet of floor space, yet does the work of much larger machines with speed and accuracy.

The unit is adjustable and will shear material up to 24 in. wide and 0.032 in. thick in mild steel. Machines for wider material can be had on special order. The speed range is variable from 30 to 160 fpm and can be synchronized with other machines in the line.

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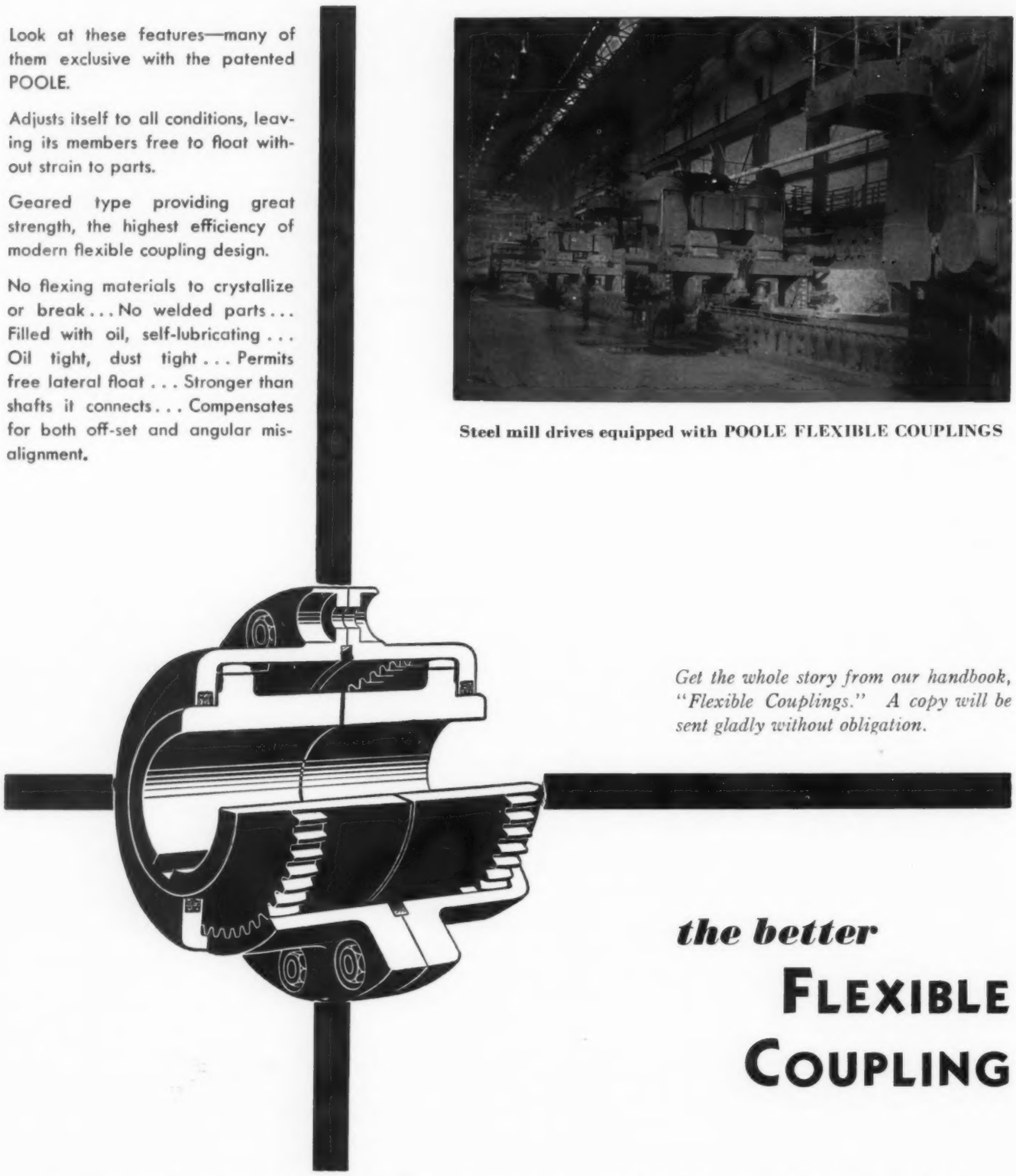

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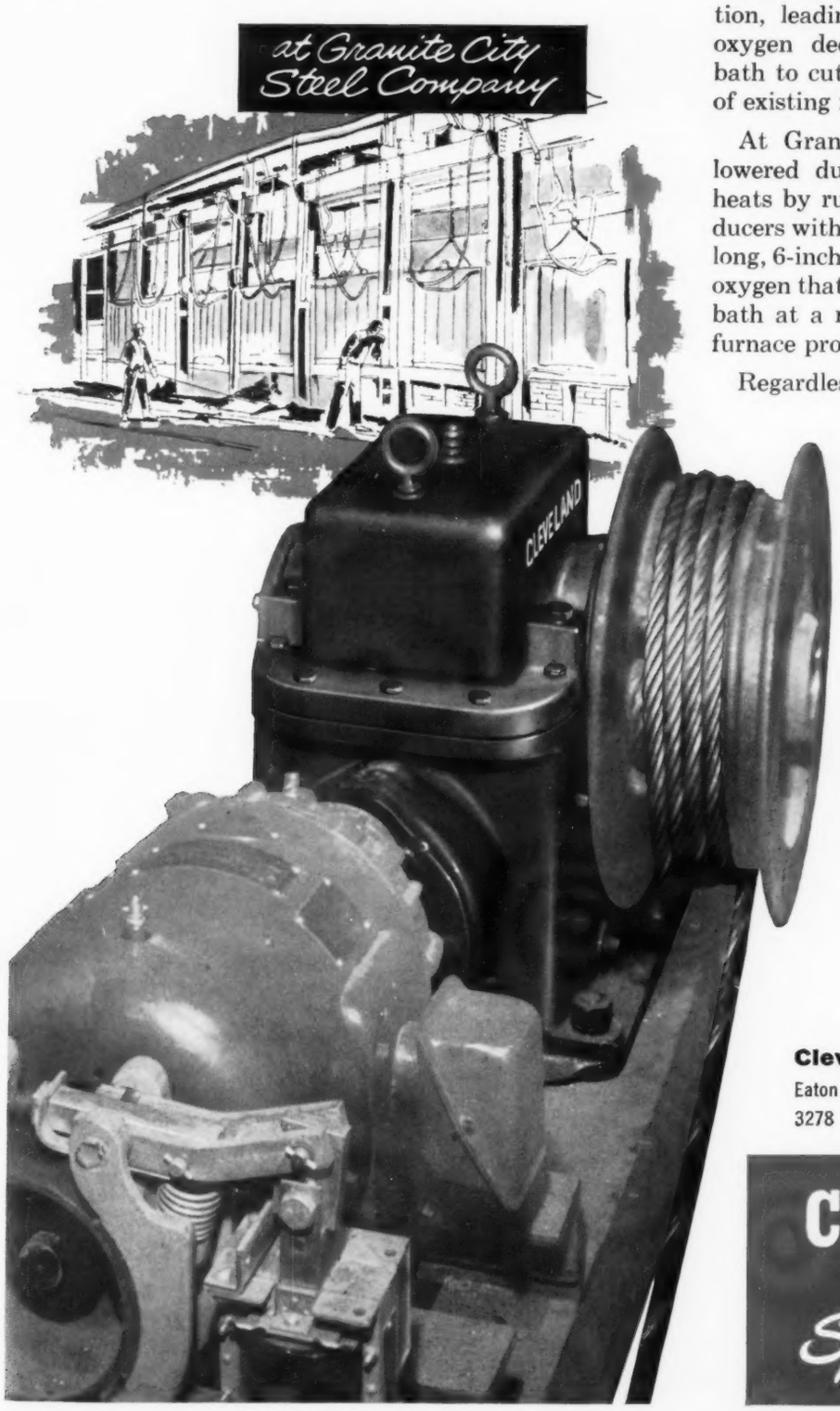

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